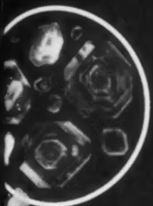
CHEMISTRY



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Chemical Trends

➤ THE EDITORS OF CHEMISTRY believe that its readers should be acquainted with the professional literature.

In the first issue of Chemical Engineering (McGraw-Hill) to appear on a new every-other-Monday publishing schedule (Jan. 13), the top technical trends of the process industries of the past year were presented:

1. With chemical engineering methods penetrating deeply into extractive metallurgy, uranium leads as resin-in-pulp and continuous ion exchange vie with solvent extraction.

2. Hydrogen plus chemical engineering is doing several steel industry jobs. Most striking is direct iron-ore reduction in fluid beds.

3. With germanium purification substantially conquered, two large germanium rectifier installations are operating.

4. Rockets, missiles, high-temperature process uses are demanding better materials. Both metals and non-metals are showing the way.

5. Boron-based chemical fuels are big news in military aviation today. However, solid propellants may gain preference in missiles.

6. Long the dream of efficiency-conscious engineers, fuel cells may be on the verge of commercial success. The Army is now using them.

7. Commercial use of one 72-mile pipeline and experimental use of another 108-mile line mark a future trend in solids transport.

8. Though Fischer-Tropsch is economically out in U. S., other solid-to-liquid fuel processes are getting, or are about to get, a real trial.

9. From xylene oxidation to a variety of polymer developments, better understanding of catalysis is paying off in simplification of processes, higher yields, new products.

10. Process industries are finding that maintenance is becoming indistinguishable from operation. In some plants maintenance men already out-number operating personnel.

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Editor: WATSON DAVIS **Assistant Editor:** S. DAVID PURSGLOVE

Consulting Editor: PAULINE BEERY MACK (Editor 1927-1944)

Editor in Memoriam: HELEN MILES DAVIS (1944-1957)

➤ THE NEW SYNTHETIC MATERIAL *discovered in a basement laboratory, Porelon, can be made to contain liquid as it is being manufactured then give it off at a pre-determined rate. "Rubber" stamps with pre-inked porelon letters require no stamp pads. The machine bearings are self-lubricating and the adhesive bandages are self-medicating.*

Discovery in a Basement Lab

➤ MODERN scientific achievement usually is the result of group thinking in well-equipped laboratories.

But not always. Major breakthroughs still occur in crude basement laboratories as individuals struggle alone in the Edison tradition.

Such was the experience of Harry Leeds, who discovered porelon, one of the most promising of the new basic synthetic materials developed since World War II.

Porelon is the first material in which liquid can be contained, as it

is being manufactured, then given off at a predetermined rate. It means that, for the first time, it becomes possible to produce some liquid products, complete with container and applicator, in one relatively simple manufacturing process.

Rubber Stamp Already Inked

It means a "rubber" stamp with pre-inked porelon letters (no ink pad necessary) capable of making more than 50,000 clear impressions! — and thousands of similar product applications in almost every industry.

Leeds and John Levey, with whom he teamed up about 15 months ago to form Perma Industries, Inc., are sitting on a technical bombshell that already has thrown scores of U. S. corporations into a tizzy.

Leeds, born in London, came to the U. S. in 1930 with his parents, three brothers, and three sisters. His father, Ascher, worked as a tailor to support them.

Wanted Education

An indication of Harry's mettle came when he enrolled in night classes at the Manhattan High School of Aviation Trades, to study aircraft mechanics — and promptly took a "job" at Floyd Bennett Field, at no pay, "to get experience."

Later, working as a die maker's helper, he decided to attend Cooper Union School in New York. Entrance was by competitive examination only. Harry, lacking early educational opportunities, bought algebra and engineering texts in second-hand bookstores and studied nights.

He was among 100 admitted from the 3,800 who took the tests.

At Cooper Union, Harry helped build one of the first X-ray defraction cameras developed to study molecular structures. He also attended Brooklyn Poly Tech.

Leeds got his first paying job with a company specializing in plastic molds. At the time, he recalls, there were no books on the subject available. With typical thoroughness he took home all the parts the company ever made, designed molds for them, then compared his work with that of the company.

Within two years he had designed molds for every part the company had produced during the previous 15.

After vinyls became available, about 1936, Leeds helped pioneer both the slush casting and electroforming techniques through which the new plastic gradually came into wide use.

Leeds' career, since this beginning, has included work in production engineering and as a project consultant in the plastics industry.

Science and Fine Arts

During all this time, however, his inquiring mind constantly led him into mazes of basic research — and oil painting. He worked at home, at night, with whatever materials and tools were at hand.

In 1948, in the basement laboratory of his Brooklyn home, he set out to develop a more life-like skin for dolls. It was during these experiments that he discovered the principles that led to the development of porelon.

Like many "hand made" laboratory products, however, porelon could not be produced commercially. Another eight years of homework, as it turned out, was required to make commercial production possible.

A basic patent covering the manufacture and use of porelon, for hundreds of products in many industries,

was issued only last year. Additional patent protection on a world-wide basis is pending.

Leeds moved his family to Los Angeles in 1951 and, still working as a consultant, set out to attract capital. But he lacked a balance sheet. Several financial groups looked cursorily — and turned away. They returned, a few months ago, but it was too late.

He Is Just Beginning

John Levey, a West Coast businessman, heard about porelon early in 1956. He put together a syndicate to finance additional research and production and, without breaking stride, put the first porelon product, the Perma Stamp, into production. This product, after market tests in several cities, was put on the market about Oct. 1, 1957.

Perma Industries, Inc., a California corporation, was formed early last year with Levey as president and Leeds, a long way from his Brooklyn basement, vice president - research.

Leeds now is looking forward to the modern new laboratory building Perma will occupy shortly in Los Angeles.

Top 1957 Science Events Listed

➤ The top important advances in science and technology during 1957 as picked by Science Service are:

1. Launching of man-made earth satellites, or artificial moons, called sputniks, by Soviet scientists, the first placing of an object in outer space into an orbit around the earth.
2. Development of a blunt nose for U. S. missiles that beats their heat death when they return from their outer space trajectory into the atmosphere of the earth, thus allowing H- and A-bomb loads to be carried by intercontinental ballistic missiles.
3. Successful use of vaccine against the world-wide Asian flu epidemic.
4. The Nobel-Prize-winning demonstration that a previously accepted law of matter, the conservation of parity, is not rigorously true in weak nuclear reactions.
5. Photographing of the sun from an unmanned balloon at high altitude showing greater detail of the surface of the sun.
6. Addition of chemical element 102, named nobelium, to the periodic table through synthesis of a small number of its very radioactive atoms.
7. Occupation of Antarctica as part of the IGY, which began in midyear, and the cruise of the atomic submarine Nautilus under the arctic ice sheet.
8. Improvements in electronics and related devices, including a chemical memory device, better batteries, generation of electricity from radioactive heat and new improvements on transistors.
9. Discovery in the blood of schizophrenic patients of a substance that produces the psychotic symptoms in normal persons.
10. The awakening in America, engendered by the Soviet sputniks, of the necessity of better and more widespread training of scientists for the future and the need for more basic or pure research to provide technological advances for the future.

1957 Was
Only a Preview

Science Forecast for 1958

by WATSON DAVIS

➤ A ROCKET may reach the moon in 1958, not a man-carrying space vehicle but a more modest missile. This may be aimed to circle the earth's natural satellite. Or it may splash a gentle sign of man's prowess on the moon's surface, perhaps a marking dye. Or it may explode a hydrogen bomb on the moon, where it will do less harm than on earth, even if it contaminates that heavenly body.

A rocket to the moon is no 1958 certainty, but it is not too much harder to get to the moon than it is to launch a big satellite.

There will certainly be more ventures by man's rocket creations into outer space. Additional satellites will be launched by both Soviet Russia and the United States. There may be beginning attempts to join two satellites together, the first step toward a space platform. One of the earth-circling satellites may carry a television device that will spy upon all portions of the globe's surface successively as it orbits, which would be useful for knowing and forecasting the weather but also in a dangerous way useful for military purposes.

Facts From Satellites

More important for future knowledge will be facts that satellites, both American and Soviet, will return to earth by their "beeps" as to what exists in outer space just above the earth's atmosphere. Scientists are curious as to what exists 180 to 600 miles above the earth, what atoms and ions are there and how densely placed they are. This information is important for understanding many natural phenomena and for future space explorations.

Defense-wise, there will be more rockets and missiles readied, tested and put into production in a rush to catch up with the Soviet progress, if that nation actually is ahead of the United States in that field. Due to secrecy, we are much more likely to know when things go wrong and there are failures than when there are successes and significant progress.

Balloons and Accelerators

There will be very high balloon flights taking apparatus for many hours above 99.7% of the atmosphere. This will settle the open question as to whether there exist in the cosmic radiation the hearts of light elements, lithium, beryllium, and boron. This will give clues on the origin of the cosmic rays, for such light nuclei may be evidence for gigantic thermonuclear reactions in the universe.

Construction will continue on four new high energy accelerators for exploring with immense energies the constitution of matter. Princeton and Pennsylvania Universities are building a three billion electron volt proton synchrotron, Harvard and M. I. T. a six billion electron synchrotron,

Brookhaven National Laboratory a 30 billion proton synchrotron and CERN at Geneva also a 30 billion proton synchrotron. The last three use strong focusing magnets and therefore form a new class of accelerators. All of these powerful "atom smashers" are planned for completion in early 1960 and assure major new discoveries in the atomic field.

In the gigantic cosmic "machines" that are in the galaxies and aggregations of stars, there may be discovered that new differences exist in such familiar objects as variable stars and clusters. Although at times both the satellites which are so relatively close to us and happenings on the surface of the earth monopolize our attention, there are cosmic dramas being performed in the vast spaces of the universe that our telescopes, receiving both light and radio waves, will watch and report. Radio astronomers are hopeful that 1958 will witness the practical use of the maser in radio astronomical problems. The maser, named from "microwave amplification by stimulated emission of radiation," is a device that causes solids to oscillate at microwave frequencies and makes possible higher amplifications. Applied to radio telescopes it is expected the utility of these relatively new viewers of the universe will be increased a hundredfold.

Computers to Help Air Travel

Control of the nation's constantly increasing air traffic will receive the benefit during the coming year of elaborate devices that work more rapidly than human abilities. Computers, memory drums, data processing apparatus are now required to speed up air traffic control because of the increased number of passenger flights and the appearance of jet planes. The human mind and voice are no longer fast enough. The result of the new progress by the Civil Aeronautics Administration will be safer air transport.

Medicine Will Advance

The big research push against cancer may begin to pay off in saving doomed lives. A chemotherapeutic agent against cancer is the most dramatic possibility in medicine today. It will take months and years of clinical testing and evaluation, even if the hoped-for discovery is made. There are two methods of attacking the problem of cancer from a research standpoint. One is a widespread search and testing of all possible drugs, thousands of them, on the shelves of the pharmaceutical houses or synthesized for the purpose. The other is extensive basic research into the fundamental nature of malignancy. More money is being spent at the moment on the drug testing, but it may be that the fundamental research, slow as it seems, will pay off first.

The fight against virus diseases will continue, with the common cold, a multiple disease or bundle of diseases, as a target for progress in 1958. Some of the other diseases that plague us consistently may give signs of being brought under greater control, as polio has been by its vaccine.

There is the possibility of a new epidemic of an old disease appearing somewhere and threatening to sweep the world, as Asian influenza did in 1957. Medical scientists will keep alert to this and we can be confident that defenses will be built against any natural disease menace, just as during

the war and since there have been major advances toward being ready to counter any attempts at disease or bacteriological warfare.

A great need in the modification of human personality now is recognized as a way of elevating the mood of an individual by means of a drug. Tranquilizers have been achieved and are in wide use, both in the general population and in mental hospitals. New euphoriant drugs are needed. These will have usefulness in treating depressions, both those that reach the seriousness of needing psychiatric attention and possibly even the day-by-day "down in the dumps" feeling.

Science Will Attract Youth

The youths of America who want to become the scientists, technologists and engineers so urgently needed for the future may get a "break" in 1958. Due to the sputniks and fear of Soviet scientific and educational progress, there may be more resources for bolstering scientific interests on the part of students, particularly in our secondary schools. There may be extensive support voted by Congress and scholarship programs of considerable size.

The effective method of helping boys and girls in their 'teens do their own science projects and experiments, as inspiring preludes to science careers, will get reinforcement, nationally and at local levels. More than 300,000 youths will do science projects and exhibits and show them in thousands of science fairs in schools and in over 150 regional fairs, which will culminate in the National Science Fair in May at Flint, Mich.

Boys and girls will ask more questions than ever. They will have fun and learn by doing, aided by the experts and the teachers in their community. A continuing renewal of the scientific and engineering manpower of the nation will result.

* * * * *

POSTMORTEM ON 1957 FORECAST

The science forecast for 1957 issued a year ago was fulfilled in many respects.

It was "the year of the missiles" as predicted and "the first of the earth satellites to be launched by man's inventiveness" did "sail upward on a three-stage rocket," although it was not a U. S. but a Soviet achievement.

The International Geophysical Year began to produce results, as foreseen.

There was progress in the building and operation of large "atom smashing" accelerators and the Soviets did take the world's lead with a ten billion electron volt machine (run at 8.3 Bev), although still bigger accelerators began building in the United States, as also forecast.

The Atomic Energy Commission did reduce, as expected, the biological safe dose or tolerance level for radiation.

The search for a chemotherapeutic agent active against cancer continued on an enhanced scale, but as also expected there was not a "breakthrough."

There was, as anticipated, an important discovery of fossil man, the Neanderthal skeletons in Iraq.

The national science youth program accelerated even more than foreseen, due to the situation following the sputnik satellite launchings.

The Cost of Chemistry's Contribution is Low

Chemistry – a Bargain Sale

▸ THE CHEMICALS in your daily life may cost just a few pennies, but the dividends are often startling.

About 21 cents worth of chemicals brings your television screen to life, for example. Another quarter's worth does the cooling job in your refrigerator. The essential chemical in your automobile battery — sulfuric acid — costs about three cents.

It costs only a fraction of a cent for the chemical that protects a loaf of bread from mold. Another fraction of a cent buys enough chemistry to keep the weekly wash glistening white. The chemical anti-knock compound in a gallon of gasoline costs only a few mills.

About 12 cents worth of nylon goes into a pair of sheer hose. A 15-cent investment in dye colors a man's suit or a woman's dress. A tiny gear, made with less than a penny's worth of nylon plastic, insures smooth operation of your camera in all weather.

These are a few of today's chemical bargains. None of these products would exist as we know them without a light but vital touch of chemistry. And there are many more like them.

Many of these chemicals are produced in bulk by large companies like Du Pont, which gathered the facts for this survey, but most of them might never reach the consumer in usable form were it not for the skill, ingenuity, and know-how of thousands of processors, some big, but most of them small businesses, who are the customers of the chemical industry.

Refrigeration

The interdependent relationship of businesses makes these bargains in chemistry possible. An outstanding instance of a chemical product doing a giant's work at a midget price is in home refrigeration which, typically, has been made commonplace by the research, invention, and large-scale production of big business combined with the special skills of market development, distribution and servicing by small firms.

Gas, which costs the price of a pack of cigarettes, is the key factor in providing for the home owner many years of dependable cooling in a refrigerator, freezer or window air-conditioner. Matter of fact, the ice you would use to get equivalent cooling effect would cost several times that much every day and — remember the pan under the ice box.

Today, a quarter pays for the amount of "Freon" fluorinated hydrocarbon refrigerant that cools the average nine-cubic-foot home refrigerator.

Despite its low cost, the refrigerant is potentially the longest lived part of the cooling equipment. Unless a leak develops in the piping coils or mechanical parts of the refrigerator, the original "Freon" will go on doing its work forever.

Television

Your television set would be just

another radio were it not for 17 cents of luminescent chemicals or phosphors that coat the picture tube, converting the electronic bombardment into visible images and bringing the program to life on your screen.

There is only one trouble with this arrangement. Phosphors and glass repel each other. To overcome this dislike, manufacturers of television sets use Du Pont's silicate as an adhesive agent to bond the phosphors firmly and evenly to the TV screen.

The silicate used in this small, but crucial operation adds four to five cents to the cost of your set.

Nylon

Nylon provides numerous examples of big results from little amounts. Hosiery manufacturers, of which there are about 500 in the nation, use only about 12 cents worth of raw nylon in a pair of women's stockings. In one pair of typical 51 gauge, 15 denier stockings there are 5,437 yards of yarn knitted into more than 2,000,000 loops. The rest of the price is for the knitting, dyeing, distribution and other costs necessary in the manufacture and sale of the hosiery by thousands of other firms, nearly all of which are small.

A fraction of a cent's worth of a chemical delusterant in the nylon yarn insures hosiery and other apparel articles against excessive sheen.

Nylon is a plastic material as well as a textile fiber and, as such, is fabricated into thousands of different mechanical parts, many of them small ones. Many refrigerators use door-latch rollers made of nylon costing a fraction of a cent to provide smooth, quiet closing.

The plastic has solved the problem of operating a 16-millimeter motion picture camera in cold weather when lubricating oil is likely to slow down smoothness of operation. A tiny shutter drive gear, three-sixteenths of an inch in diameter, made of half nylon and half brass does the job without need for lubrication.

Fishing Rods and Transistors

A penny's worth of "Volan" methacrylate chromic chloride chrome complex serves as a bonding agent in glass fiber laminates for fishing rods. A few cents worth of "Mycoban" calcium propionate inhibits the growth of mold and other micro-organisms in 100 loaves of bread.

Silicon, one of the purest materials known to man, sells for an average price of $270 a pound. Yet the amount of the material used in transistors — which range in cost from $5 to $50 — is worth about seven cents. In a large economy size box of detergent there is seven mills worth of optical bleach, the chemical which makes your linens appear snowy white.

Sawdust is proving to be an effective adsorbent that reduces the disposal cost of liquid radioactive waste and simplifies its handling.

A belt of countries in free Asia contains about 30% of the total world population, yet produces only about eight percent of the total global output.

Asian flu is more contagious than other types.

The Postman's Bag is a Scientific Horn of Plenty

Dear Sir: Please send me . . .

by Shirley Moore

► A strip of postage stamps will open a modern Aladdin's cave of free gifts and inexpensive materials prepared for science students and teachers by American industry, government agencies, famous museums and professional organizations.

The magic words are "please send . . ." The genie in this case is no wispy mist of smoke, but the United States mails.

Browsing through Science Clubs of America's list of some 200 sources of such gifts and aids to science activities is as much fun as the childhood occupation of paging through magazines and eagerly cutting out coupons offering a free sample or a "gorgeous gift, enclose ten cents for mailing." But this time the family mail box will not overflow with liver pills, cheap perfume, yarn swatches and dog biscuits.

Instead you can have delivered to your school information and inspiration for original research projects and a variety of experiments, fresh teaching ideas and materials, sources of unusual science club programs, beginnings of new hobbies, and expert advice on scientific careers.

What new fields have caught your interest? What subjects have you wished you could explore a little? Which problems need new answers?

You have not only three but dozens of "magic wishes." Professional experts and well-known manufacturers and suppliers are ready and willing to help you get started.

Why Does . . . ?

Would you like to investigate questions that have no answers . . . yet? Maybe you are intrigued by chemical problems; for instance, the reason why substances — like mica, to name an interesting one — stick together. This is a fundamental question of surface chemistry. If you do not know much about mica to start with, it might help to study a free booklet about it. Or perhaps you would like to read available leaflets on laminated and molded thermosetting plastics, or on vulcanized fiber, or to have a general catalogue of these materials.

If you are interested in knowing something about new and coming chemical research as related to food, there are free booklets on that subject also. Fluorochemistry and fluorobiology are two of a very good series of pamphlets on ultraviolet studies at five cents each. An excellent wall chart of the chemical elements (35" x 50") can be purchased for $1.00.

For Club Meetings, Too

Suffering from mind-blank in planning stimulating science club programs? Did you know you can borrow free films on such topics as plastics, air conditioning, glass, cancer and many other fields of modern science? These are made available by well-known industries and founda-

tions. Many low rental films can be secured from your nearest city, county or state university or college through the courtesy of a motion picture association.

Teachers may discover that many of their problems have decidedly attractive and unusual answers. For instance, had it occurred to you that air lines and railroads prepare free maps, bulletins, color prints and other educational services especially for teachers?

And the Classroom

It might be an excellent idea for your classroom to have a series of free booklets on various aspects of safety such as the use of benzene, solvents, machinery, avoiding the hazards of amateur chemistry, and first aid.

You can receive free posters (14" x 17") twice a month during the school year and free booklets on the research activities of one of the country's large industries. The same organization will send you free catalogues listing motion pictures for loan and its school publications, which include career guidance bulletins and a comic book series on such subjects as electricity, jet power, the atom, light and electronics.

Such familiar and famous organizations as the National Audubon Society and the National Wildlife Federation will help to make teaching more colorful, more fun and more rewarding for both teacher and students. They offer really excellent bulletins, photographic prints in color and wall charts at very small cost. Imagine, for example, how exciting your winter program can be if it is planned around attractive nature

➤ A SCIENCE CLUB *sponsor helps members select materials they need from a small collection of the many available free, or at low cost, from organizations cooperating with Science Clubs of America.*

charts (25c each) on such subjects as seeds, leaves, twigs, evergreens or animal tracks, combined with bulletins (about 10c) on rock stories, how to forecast the weather, how a thunderstorm grows, mysteries of bird migration and special winter projects.

Kits — By Subscription

Another familiar institution, Science Service, offers you inexpensive experimental kits designed for individual, classroom, science club and school museum use. A new "Things of Science" kit is issued each month, featuring actual samples, information, suggested experiments and museum display cards for such absorbing studies as plastics, titanium, copper, paper making, "tippe tops" and thermal insulation. (Membership $5.00 a year;

or 3 kits for $1.50, 75c each, $13.50 for a complete collection of 29 units).

When coal appears in the curriculum, teachers may have a wealth of free material ranging from a play to a classroom project, a cutaway view of a coal mine, a map of coal areas in the U. S., a chart of chemical derivatives and a 22-page color reprint from a widely known encyclopedia. Railroads are similarly covered by free booklets, free teacher kits and a gift set of 35mm. color slides for each school.

The catalogue of a science supply company is one to linger over, for it offers complete ingredients for the greatest variety of scientific projects and is illustrated by particularly good photographs. Periodic bulletins are also issued on special subjects and materials usually difficult if not impossible to find.

If there is a modest fund available to purchase the kits (at 10% discount), your class can learn by building instruments and models and performing suggested experiments with them. In this appealing way you can cover such subjects as a model weather station, electricity, optics, a backyard zoo, construction of a globe, geology and a model oil refinery.

Outstanding museums offer teachers and students free circulating exhibits (where the borrower can furnish transportation), slides, film strips, movies and photographs. Handbooks and bulletins on specialized subjects range in price from five cents to several dollars.

Career Information

Think of the club programs you could build around careers in science! Some of the best known professional societies will help you with materials on their specialties in astronomy, chemistry, dentistry, dietetics, archaeology, botany, geology and paleontology, engineering, teaching, technology, nursing, and many others. Using some of these as a base for a general symposium, you could go on to panel or individual discussions by scientists in your community.

Would your science club, or some member of it, like to carry out genetic studies? If the club sponsor will sign the request, it is possible to get free cultures of live Drosophila melanogaster, and a guide to genetic experiments on these fruit flies, from a national institution.

If you feel that you scarcely know where or how to begin on a project, you can learn how under the guidance of a national organization or a government agency such as the F.B.I., Soil Conservation Service, Forest Service and the Weather Bureau. "Co-Projects" and ways of carrying them out are suggested, and help and information is offered. Often you can talk over your problems with local representatives and, of course, you can confer by mail with "headquarters." Such organizations as the American Automobile Association, American Heart Association, American Red Cross, National Foundation for Infantile Paralysis and the Interlingua Division of Science Service have equally interesting projects that they will share with you or your science club. Co-Projects would be especially good scientific experience for junior high or elementary school science clubs or classes.

From Hi-Fi to Computers

Has the electronic bug bitten you?

There are circuit and calculator handbooks for you that cost as little as 25c; free booklets on meters, flow signal transmitters and electronic devices; and a resistor color coder for 10c. Other books, such as tube manuals, cost a little more; receiving tube manual, 75c; tube picture book, 25c; transmitting tube manual, $1.00; book on transistors and semi-conductor diodes, 25c. Hi-fi enthusiasts will like an excellent 25c book, "How to Understand High Fidelity."

Spectrophotometry may eventually solve some of the mysteries of cell processes, perhaps using ultraviolet or infrared light. If you have thought of building yourself a spectroscope and taking your first steps into this fascinating field, there is a company which handles inexpensive surplus prisms, lenses, instruments and other equipment. They also issue booklets, priced from 10c to $1.00, telling you how to build spectroscopes, projectors, magnifiers, infrared units, etc. Their free catalogue is full of potential ideas!

Microscopes and X-rays

Or if microscopy is your field, there are free notebook sheets and a free booklet on the principles, use and care of the microscope. There is an especially good booklet on the compound microscope that would be helpful and informative to students using school microscopes.

If you are already looking forward to a lifetime of atomic research, you can get off to a flying start with free booklets on X-ray analysis, magnetic-particle testing, the electron microscope, and a free X-ray spectrograph chart showing characteristic X-ray lines which identify elements from No. 11 to No. 98. Another booklet (35c) suggests lab experiments with radioisotopes for high school demonstrations. With this booklet you can get free leaflets on radiation safety in schools and prices of radioactive isotopes which are for sale without an AEC license.

If you are searching for still different answers, or you would like to explore a pleasant bypath, what will you have from this sampler? Glass blowing, embedding in bioplastic, micrometer reading, gyroscopes, sponges and chamois, wilderness areas, wildflowers, or glycerine? (Did you happen to read about the successful experiment done by a 14-year-old Maryland girl, using glycerine in cooking processes?) There are interesting bulletins on all of these, free or for about five or ten cents.

Many other gifts, services and low cost materials are available, of course, since this has been a rather random sampling . . . or have you already left for the post office?

Materials mentioned in this article, addresses of companies and agencies, and many additional listings may be found in the Science Clubs of America Sponsor Handbook which presents detailed information on science clubs, science fairs and projects, the National Science Fair and the Science Talent Search for the Westinghouse Science Scholarships and Awards. SCIENCE SERVICE, *1719 N Street, N.W., Washington 6, D.C., will send a copy to teachers and science club sponsors free of charge, or to others at a cost of $1.00 a copy.*

For The Home Lab:

Silicon

by Burton L. Hawk

➤ The element silicon is a paradox. It is as plentiful as the sands that cover the earth, yet it is virtually unfamiliar to the average person. It has been used by man since the Creation in the form of its compounds, yet today the complex structure of many of these compounds is still not completely understood. And although these compounds have had a long history, they still have perhaps a greater future. For many new compounds of silicon remain to be investigated thoroughly and hundreds of other possible compounds have not yet been prepared in any quantity.

The fact that silicon itself has no startling properties might account for its lack of popularity as an element. It does not glow in the dark, will not catch fire in water, will not react with acids, is extremely difficult to melt, and will not react readily with most of the other elements.

You can purchase silicon "lump"-form from a laboratory supply house. You will find it to be bluish-gray with a metallic luster somewhat similar to blue coal in appearance. These lumps are quite hard. Note that you can scratch glass with silicon.

Place a small lump of silicon in each of three test tubes containing dilute solutions of nitric, hydrochloric and sulfuric acids. The element is not attacked by these acids. It will, however, dissolve in a mixture of nitric and hydrofluoric acids. Now, drop a lump into a strong solution of sodium hydroxide. Note that here the element reacts to form sodium silicate and hydrogen. If the action is slow, apply gentle heat.

Silicon reacts moderately with oxygen to form silicon dioxide and with chlorine to form silicon tetrachloride. If you would like to try preparing these compounds, heat a small lump of silicon directly in a Bunsen flame for a short while, then insert in a bottle of oxygen or chlorine. Use long-handled tongs or a deflagration spoon for this purpose, as the element must be heated to quite a high temperature before it will react. Also, be sure to use only a small piece.

Historical Note

Sir Humphry Davy surmised that silica was not an element, but he could not prove his theory because he failed to isolate silicon. He made several attempts with his famous voltaic pile and even tried to reduce the silica with metallic potassium which he had prepared, but was unsuccessful. An impure form of amorphous silicon was probably obtained by Gay-Lussac and Thenard when they reacted silicon tetrafluoride with potassium.

In 1823 Berzelius refined the method of Gay-Lussac and Thenard and finally succeeded in obtaining the purest variety of silicon up to that time, also in the amorphous state. It was not until 31 years later that the crystalline variety of silicon was prepared. This was accomplished by Henri

Sainte-Claire Deville. He decomposed a sodium aluminum chloride compound containing silicates with the electric current and obtained a rather unique mixture of silicon and aluminum. When he dissolved the aluminum away with acid, the crystals of silicon remained. This rather haphazard method produced the first crystalline silicon made by man. And thus is the history of the second most abundant element on earth.

Preparation of Silicon

You can prepare silicon in the laboratory with much less effort than Berzelius or Gay-Lussac and Thenard by simply heating silica with magnesium.

Mix together thoroughly 3 parts of silica (silicon dioxide) with 1 part of powdered magnesium. *Use only small quantities!* Place the mixed powders in a small porcelain crucible and cover with a loosely fitted lid. Apply heat and stand back! The reaction might be violent, but it is perfectly safe if you use small quantities. After you are sure that all action has ceased, allow the crucible to cool and dump the contents into an evaporating dish. Add dilute hydrochloric acid to dissolve the magnesium oxide, unreacted magnesium, and magnesium silicide. Stir and heat, if necessary, until all reaction ceases. The brown powder that remains is crude amorphous silicon.

Try dissolving your silicon in concentrated sodium hydroxide. It should dissolve with brisk action as hydrogen is formed. You may try the other experiments with silicon as described above if you wish.

Impure silicon can also be obtained from sand. Proceed as outlined above, using 3 parts of white sand (as fine as possible), and 1 part of powdered magnesium. Sometimes phosphates are present in sand and hence magnesium phosphide is formed by the reaction. If this is the case, phosphine is obtained when you add hydrochloric acid and will ignite as it comes into the air, sometimes with miniature explosions. Wait until this display has finished before you attempt to heat the solution.

As you have deduced by now, silicon occurs in two forms, as a brown amorphous powder and as a bluish-gray lustrous crystalline solid. It melts at about 1420 deg. It is quite inert and reacts readily only with fluorine. When heated to a high temperature with sulfur, carbon or nitrogen the respective sulfide, carbide and nitride is formed. When heated with metals, the *silicides* are obtained, such as magnesium silicide.

The amorphous form can be converted into the crystalline variety by dissolving the powder in molten zinc. After the zinc solidifies, it is dissolved in hydrochloric acid. The crystalline silicon remains behind.

The element itself is used sparing ly. Alloyed with metals, it is used much more extensively. But the compounds of silicon present a different picture. They are widely used in a multitude of ways in thousands of everyday products. We will investigate the compounds of silicon at a later date.

Starting in the Western Pacific region, within five months Asian flu girdled the world.

Atom Smasher Will Be Obsolete When Built

▶ The Atomic Energy Commission's biggest atom smasher, a 12.5 billion electron volt proton synchrotron to be built at Argonne National Laboratory near Chicago, will be obsolete before it is finished in 1962.

This is the considered opinion of many of the country's top experts in high-energy nuclear physics. They think the AEC is making a mistake to build such a machine at this time.

The decision to do so was made at the very highest level within the AEC. Back of the go-ahead signal is a long history of disagreement between two scientific groups, the scientists at Argonne and those of MURA, or Midwestern Universities Research Association, organized by 15 Midwestern universities to promote research on high-energy accelerators.

New Design

The MURA scientists are working on the third model of a radically new kind of atom smasher, capable of producing effective energies of hundreds of billions of electron volts, far in excess of any other machines now planned. They are using computers extensively to help them determine the feasibility of this idea, and their work is supported by both the AEC and the National Science Foundation.

The idea behind the super atom smasher is to hurl two atomic beams at each other, instead of the single beam crashing into a stationary target as in present machines. Suggested name for such a machine is "synchroclash," also known as the intersecting beam accelerator.

Duplicate Cosmic Rays

Scientists build atom smashers with higher and higher energies to create and study new nuclear particles, as well as to examine in greater detail the reactions of those already known. Man-made machines are now beginning to duplicate the lowest part of the cosmic rays' energy range.

Russia, with a ten billion electron volt machine, now leads the world in producing the highest energy particles. Some scientists charge that the main reason for deciding to build the 12.5 Bev machine at Argonne was to outdo the U.S.S.R. Since only $1,500,000 of the estimated $27,000,000 the new U. S. accelerator will cost has been made available for initial design work, they believe the AEC should admit its mistake and not build it. By the time the machine is finished, two other, considerably more powerful atom smashers will be in operation. One is the alternating gradient synchrotron, under construction at AEC's Brookhaven National Laboratory, Upton, Long Island, N. Y., and the other a similar machine being built in Geneva by the European Organization for Nuclear Research, or CERN.

Both these accelerators, which will be about one-half mile in circumference, will have energies in the 25 to 30 billion electron volt range.

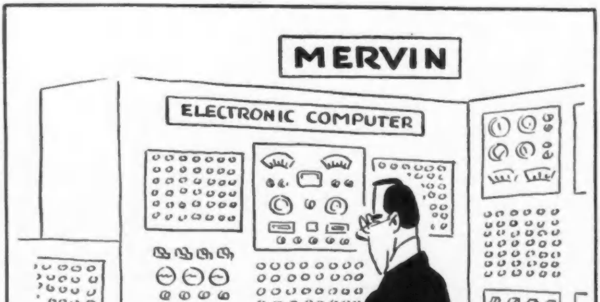
Russians Plan 50 Bev

The Russians have revealed plans for building an accelerator to reach 50 billion electron volts, or Bev, also on the same principle, but it is not

known whether or not construction has started.

Also in dispute is the location of the proposed MURA accelerator, if and when it is approved. The MURA scientists want to construct it near the University of Wisconsin, but the AEC contends this would cause needless duplication of facilities already available at Argonne.

MURA members are the Universities of Chicago, Illinois, Indiana, Iowa State College, State University of Iowa, Kansas, Michigan State, Michigan, Minnesota, Northwestern, Notre Dame, Ohio State, Purdue, Washington University at St. Louis, and Wisconsin. Dr. H. R. Crane, physics professor at the University of Michigan, is president of MURA.



➤ "YES, BUT *can it sharpen pencils and empty waste baskets?*"

The Armed Forces May Need Your Invention

➤ A GOVERNMENTAL plea to the average American for ideas and inventions of space platforms, jets and rockets has become a best-seller.

It also promises to become a potential source of new developments heretofore unthought of.

In the first days of November, the National Inventors Council of the U. S. Department of Commerce issued a 34-page want-ad entitled "Inventions Wanted by the Armed Forces." The booklet lists 387 inventions needed by the military and invited the nation's amateur and professional inventors to send in their ideas.

The demand for the attractive blue-covered booklet has been so great that the National Inventors Council has been having trouble meeting it. The first run of 10,000 copies has long been exhausted. A second run is now on the press, and a third and possibly fourth run is anticipated.

"We think it will be out of all proportion to similar pre-sputnik pleas and will have a total circulation of from 30,000 to 40,000," Leonard Hardland, the Council's chief engineer said.

Inventions to match those needed by the Armed Forces have been trickling in, too. However, it takes time and thought to turn out worthwhile ideas, the Council outlines, and it will be sometime in the future before all the ideas are received and evaluated. The first ones indicate that they are being developed by American amateurs, as well as professionals, and from all walks of life.

In addition to inventions relating to space travel, jets and rockets, the Armed Services are in need of developments in many other areas. One of these has been termed "Blue Sky" Problems and includes, for example, a non-magnetic compass; a destructive ray that is capable of producing "death rays effective at 500 yards without excessive power input;" a practical means for getting men and vehicles underground in less than a minute; and an atomic fire-fighting method.

The booklet is free for the asking and outlines how the NIC works and what its requirements are. It can be obtained by writing to the National Inventors Council, U. S. Department of Commerce, Washington 25, D. C.

Uranium Refining Process Improved

➤ A STANDARD PROCESS for extracting uranium from its ores has been perfected to the point of 99.99% recovery of the vital metal.

Perfection of the liquid-liquid extraction process was reported by D. S. Arnold, B. G. Ryle and J. O. Davis, scientists of the National Lead Co., Cincinnati.

In separating the uranium from clay, rocks and metals that make up the ore, the aggregate is first dissolved in acids. In the perfected system an organic solvent, tributyl phosphate-kerosine, is next added to extract the uranium. The scientists believe the process may also be adapted to extract other materials.

Half of New Teachers Plan To Quit

➤ Every other person who began teaching in 1956 plans to quit teaching in five years. Two out of every ten new teachers of 1956 did not even plan to return to teaching last year.

This surprising and unexpectedly high turnover in beginning teachers was uncovered in a questionnaire survey made by Dr. Ward S. Mason, a specialist in teacher personnel statistics at the U. S. Office of Education in Washington.

Although only preliminary results are thus far available, the study implies that low salary and lack of preparation are two of the reasons behind the heavy losses among beginning teachers. Another significant factor, however, particularly in women teachers, is marriage and family.

"We suspect," Dr. Mason told Science Service, "that salary will be important for some kinds of teachers, but not others."

Dr. Mason's preliminary studies of future plans of first-year teachers show that, in general, women are far more likely to leave teaching in five years than are men.

When secondary school teachers are included, the highest percentage of those who plan to leave in five years are those teaching non-academic subjects such as home economics, music and shop.

Of the men in this category, the greatest percentage is in science and mathematics (44%). Statistics on the number of beginning women secondary school teachers in science and mathematics who will leave have not been computed because too few women teachers in these subjects were included in the preliminary sample.

Preliminary findings from the survey, published in *School Life*, the official journal of the Office of Education, show that:

1. The expected turnover for beginning teachers is nearly 20% after the first year and 50% by the end of five years. This is in comparison to the seven and one-half percent normally chalked up as annual losses to the entire teaching profession through death, retirement and other factors.

2. The turnover is significantly high when matched with the fact that the shortage of qualified teachers in the fall of 1956 was 135,000.

3. Figures on average salaries might shed some light on the heavy losses. The median salary for all beginning teachers last year was $3,600. It was highest in the Far West ($4,000) and lowest in the Upper South ($2,750).

Both a more detailed report and a follow-up study on just why the teachers leave and where they go is now being made by Dr. Mason.

Interstellar travel distances are too vast to be covered in a human lifetime unless the space vehicle can be accelerated to a speed approaching that of light — 186,000 miles per second.

In auto crashes the head is the most vulnerable part of the human body.

Don't Force Scientists into Early Retirement

➤ THOUSANDS OF experienced scientists and engineers are being forced to retire too early when they could perform vital national services, G. Warfield Hobbs, chairman of The National Committee on the Aging, warned at its New York meeting.

"A scientist in the hand is worth two in the cradle," he said, and urged that companies raise their compulsory retirement age from 65 to 70 for scientific and engineering personnel.

"While we are training young people to become the scientists of tomorrow, many mature and experienced scientists of today are being wasted," Mr. Hobbs reported.

He estimated that there are now at least 20,000 retired engineers and natural and physical scientists, most of whom are able and anxious to contribute to the nation's defense effort.

Although they may not be fully trained in the latest developments, all have a basic training in the sciences which would enable them to take over many routine scientific duties.

If only 1,000 scientists and engineers resumed only part time work, it would mean that 2,000,000 highly skilled annual man-hours could be added to the national defense effort, Mr. Hobbs concluded.

Need Brains More Than Money For Research

➤ BRAINS HAVE NOW become more scarce than money in the field of medical research, a nationwide survey of leading researchers sponsored by Merck & Co. has shown.

The survey also revealed, not surprisingly, that the great need now is for basic research. Most of the scientists held the public partly responsible for the present situation because the public approves the spending of millions of dollars to "cure cancer" but becomes disinterested about money to study cell physiology, which may or may not lead to a cure for anything.

"There's no distinction in the public's mind, between pumping a well handle and looking for a new well," one scientist said.

Other important factors brought out were that the abundance of new research funds was drawing topnotch people away from teaching. Medical schools occasionally turn down grants because it costs too much to accept them. New researchers have to be trained, and space, services and overhead have to be supplied.

The main need now is for men, not money, many of the scientists agreed. Low pay is the most critical factor affecting the shortage. Many of the researchers could make much more money in other fields of medicine. Those interviewed felt that there is a financial burden placed on competent people who decide to enter or to stay in the research field.

The hardest men to find, apparently, are the creators. There are too few men in the world who have full backgrounds in several sciences and can come up with so-called cockeyed ideas, rather than orthodox ideas.

"Orthodox ideas lead to nothing," one researcher replied to the survey.

√ *Chemistry Quiz* √

Directions: Mark within the parentheses corresponding to the answer you think is *most nearly correct*. Answers are on page 21.

1. $Ca(H_2PO_4)_2$ is used in
   ( ) 1. alloys
   ( ) 2. dentifrices
   ( ) 3. fertilizers
   ( ) 4. pigments

2. Thorium is a
   ( ) 1. bone of mammals
   ( ) 2. food preservative
   ( ) 3. metallic element
   ( ) 4. satellite of Jupiter

3. Which of the following is found in the greatest quantity in automobile exhaust gases?
   ( ) 1. carbon monoxide
   ( ) 2. carbon tetrachloride
   ( ) 3. sulfur trioxide
   ( ) 4. water

4. Which of the following does *not* belong with the other three?
   ( ) 1. cerium
   ( ) 2. ilium
   ( ) 3. neodymium
   ( ) 4. praseodymium

5. Cholesterol is
   ( ) 1. fatty
   ( ) 2. non-crystalline
   ( ) 3. odoriferous
   ( ) 4. sugary

These questions have been taken from Science Aptitude Examinations used in previous years as part of the annual Science Talent Search. Complete copies (with answers and norms) of many previous examinations are available at 10c each from Science Service, 1719 N St., N.W., Washington 6, D.C.

CLASSIFIEDS

Progressive Quirk?

➤ THE USE OF atomic-age sources of heat to produce traditional fuels was suggested to the Chicago meeting of the American Institute of Chemical Engineers by two Government engineers.

The use of nuclear reactors to supply the high temperatures needed to convert coal to gaseous and liquid fuels, was recommended by R. Carson Dalzell, chief of the branch of engineering development in the U. S. Atomic Energy Commission's Division of Reactor Development and James P. McGee, mechanical engineer in the U. S. Bureau of Mines' branch of coal gasification, Division of Solid Fuels Technology.

A drawback to commercial gasification of coal for use as fuel in other forms has been the cost of producing the necessary high temperatures. The Government engineers outlined a system that would call on nuclear reactor heat to gasify low-grade coal at 1,800 to 2,000 degrees Fahrenheit and convert high grade coal at temperatures above 2,000 degrees. The resulting gas could be burned as fuel, or could be used to produce liquid fuels and chemicals.

The authors pointed out that experimental work by the Bureau of Mines has demonstrated the feasibility of gasifying finely powdered coal at high temperatures. They added that the equipment called for in their system probably would be perfected in the course of atomic energy development.

In the meantime, coal in an Alabama deposit is yielding industrial-grade fuels without first being mined, the Bureau of Mines has announced.

Coal, while still underground, is converted to fuel gases which are piped to the surface for use, the Government announcement stated, adding that research is underway to make the process cheap enough for routine commercial use.

Bureau of Mines scientists in cooperation with the Alabama Power Company have completed a series of tests at Gorgas, Ala., in which high-voltage electrical currents are used to prepare coal seams for underground gasification.

Called electrolinking carbonization, the technique uses the heat created by passage of the current from one electrode to another, through the coal, to carbonize the coal. After carbonization, the coal seam is porous enough to permit passage of air, pure oxygen or steam, which chemically react with the carbonized coal to form combustible gases.

The Bureau of Mines reported that such gases have been withdrawn from the coal bed through boreholes in usable quantity and quality. The gases may be burned to power electrical generators or used in making synthetic liquid fuels or chemicals.

√ Answers to CHEMISTRY QUIZ on page 20. √

1, 3; 2, 3; 3, 4; 4, 2; 5, 1.

Summer Science Institutes Announced

➤ A PROGRAM for improving the teaching of science and mathematics that predates Sputnik by five years will provide summer training for approximately 5,250 of the nation's high-school and college teachers in 1958.

The National Science Foundation reported that during the summer of 1958 it will award stipends and pay the tuition for 5,000 high-school and 250 college teachers of science and mathematics to attend summer training at 108 institutes in 104 educational institutions.

Dr. Alan T. Waterman, the Foundation's director, announced awards of the grants totaling $5,340,000 to support the summer institutes.

"The summer-institutes program of the Foundation," Dr. Waterman said, "is in step with current plans for strengthening the training of scientists in the United States.

"Good science teachers are apt to be the first to stimulate an interest in science among our young people in secondary schools. But if instruction is not stimulating, and contains outdated concepts, it tends to weaken youths' motivations toward science careers. Foundation-supported summer institutes provide opportunities for thousands of hard-pressed high-school science teachers to learn at first hand the rapidly advancing developments in today's science, mathematics, and engineering."

The highly successful program for bringing teachers up-to-date in the sciences and mathematics was started experimentally in 1953. The grants, given to the institutes, cover tuition and fees and the participant receives a maximum of $75 per week plus allowances for dependents and travel expenses.

On the Back Cover

➤ ONLY A FEW *glass formulations become as well-known as Pyrex, Kimax, Pyroceram or Photolite, but hundreds are tested in glass laboratories each day. Here a Corning Glass Works technician pours an experimental patty of glass for later analysis at the Corning, N. Y., laboratory. Some new glass is harder and stronger than steel and is used as a building material. Others are extremely heat resistant and are believed to be in use as rocket nose cones. Some incorporate photosensitive compounds in their formulation and are used in making truly "three dimensional" pictures which are developed by heat.*

Free Pistons, Gas Turbines and Sun Power

Engines of the Future

by Edward Hedrick

➤ Engines of the future are in for some big changes in design and operation. They will be lighter, smaller and more powerful.

They will make use of such power sources as "free" pistons that "float" back and forth in the cylinders, unhampered by connecting rods, with the exhaust gases doing all the work of turning a turbine.

Jet engine gas turbines will be harnessed for their power, and there will be "flying engines" or ducted fans to lift flying vehicles. Even nuclear and solar engines are being studied for ways to make them economically practical power sources.

Free Pistons

Possibly the most promising power plant now under study is the "free-piston turbine" engine.

Ordinary internal combustion engines, such as the gasoline and diesel, transform the energy of an exploding fuel-air mixture into mechanical energy through the piston and connecting rod attached to the crankshaft. These conventional engines are usually "V" or "I" shaped, and the whirling crankshaft tends to set up twisting forces on the engine frame, requiring heavy, bulky supports to maintain stability.

The free-piston engine eliminates the connecting rods and twist by allowing the pistons to move freely away from the combustion chamber in opposite directions while the expanding exhaust gases help run a high-speed turbine wheel. The turbine in turn transfers the engine's power to the desired point.

The pistons are cushioned by a layer of air trapped in the rear of their cylinders, and so are "bounced" back toward the combustion chamber again for another engine cycle. The free-piston portion of the engine is called the "gasifier," since it produces the compressed gases used to run the turbine.

Any number of such gasifiers can be connected to one large turbine to increase the power of a single engine. A gasifier can be serviced or repaired while the turbine is running, in this arrangement.

A new type "free piston" engine has already been built into a farm tractor by the Ford Motor Company. The motor burns almost any kind of fuel, from high octane gas and diesel oil to peanut oil and some other vegetable oils.

It is light in weight, small and compact in volume, and requires no critical or "exotic" metals in its manufacture. At idling speeds the turbine's whine can be heard, but otherwise the noise level is low.

At the present stage of development, there are a few "bugs" that must be worked out of the engine. It is a little too heavy, three pounds per horsepower, to compete with oth-

er engines; it is sometimes hard to start and the turbine speeds are too low to provide the high operating speeds industry requires.

When these problems are solved, however, this type of engine is expected to compete in design as well as cost with conventional engines.

As an example of the free piston engine's progress in the automotive industry, the General Motors Corporation is now experimenting with a futuristic-looking free-piston-powered car called the "XP-500".

Gas Turbines

The gas turbine of jet-plane fame is also under study as a future power source for industry and automobiles.

The motor has several advantages over conventional engines; it does not need a "warm-up" testing, requiring only a spark to start the fuel burning and the turbine turning. It can be made as compact as present engines, runs much more quietly and smoothly and has a cleaner exhaust. Its servicing is simple as it has only one moving part: the turbine. Other parts are as easily serviced as present engine components.

The gas turbine's speed, power, apparent efficiency, smoothness and lack of noise were attractive to designers, but in studying the engine they ran into some difficulties. The major one was relative size or scaling: they could not build a tiny turbo-jet engine and simply attach it to a machine or car.

Jet planes making use of turbo-jet engines are propelled by hot, expanding gases shot from the nozzle of the jet, while ground machines must be driven by a wheel powered by a "harnessed" jet. This "harnessing" required many design changes, for example, the development of small-sized turbine wheels that had to operate at temperatures of about 1,200 degrees Fahrenheit.

Turbine wheels had to be made of special, expensive, high-temperature metals, the larger ones had to be specially cooled, and engine efficiency increased by heat exchangers. All these design features added up to extra bulk, weight and expense of the turbine engine.

These disadvantages are rapidly yielding to designers, as for example, in the General Motors "Firebird" experimental turbo-car, the Chrysler experimental gas turbine Plymouth and the gas turbines now under development for use in future buses, locomotives, electric generators and ships.

Gas Turbines of Tomorrow

The gas turbine may be the future means to change the energy from the splitting atom or the sun into usable power. Both the fissioning atom and the sun give off heat. The gas turbine seems to be the most efficient way of making this heat turn the wheels of industry or producing electric power for cities and communities, designers say.

Nuclear gas turbine power plants for ships, submarines and power stations are now being studied and planned. Present nuclear reactor power sources are not built with gas turbines. They make use of a heat exchanger to make steam for steam turbines.

Nuclear power plants for propelling merchant ships may be the main source of marine power in 10 or 15 years, predicts C. G. A. Rosen, speaking for the Caterpillar Tractor Com-

pany. Nuclear power for military but not for commercial aircraft is within the "foreseeable future," but he considers the outlook dim for nuclear-powered locomotives and vehicles.

The combination of gas turbine and nuclear power is not expected to be used for cars or military automotive equipment mostly because of its weight. A nuclear power plant would be saddled with about 20 pounds of reactor shielding per horsepower and this does not count the weight of the engine.

Solar-powered vehicles are still too far in the future to make definite predictions, but designers admit that use of the vast amount of solar energy falling on the earth is not impossible. In the geographical area of the U. S. alone, as much as 2,000 times the daily energy needs of the U. S. falls as solar energy.

Flying Jeep

Future cars, buses and lifting equipment may operate in the air, not on the ground, if the "aerial jeep" under development for the Army Transportation Corps becomes available to the public.

The flying cars make use of "ducted fans" to lift them smoothly and easily into the air. Ducted fans are simply propellers with wings wrapped around them. They look like "flying barrels". The prop blast is directed downward, making it possible to lift heavy objects directly, like a helicopter.

The aerial vehicles are expected to look much like regular cars, but be flatter and wider to accommodate two to four ducted fans located in conventional tire positions. The vehicles, being designed for the Army as personnel carriers, flying gun and observation platforms, flying cranes and rescue cars, are expected to be able to lift 1,000 pounds as high as a helicopter could and travel at speeds of 50 to 60 miles an hour.

One manufacturer of the four contracted by the Army to develop the "aerial jeep" envisions the future civilian use of the vehicle as the "station-wagon of the future."

Improve Present Engines

The old reliable conventional piston engines are also in for some improvement. Fuel injection is becoming more popular with manufacturers as better designs make the system more dependable for gasoline-type engines.

While diesel engines rely upon a type of fuel injection as part of their construction, gasoline engines must be especially fitted for fuel injection. The reason is they were originally designed to have the fuel-air mixture from the carburetor sucked into the cylinder by the action of the piston, not forced in as a pressurized, premixed spray, as in the fuel injection system.

Fuel injection is expected to make gasoline engines more powerful for their size and more efficient. The carburetor is not needed, and the engine can be started cold.

The Fuels

Fuels for the combustion engines of the future may have to pack more power in a smaller volume. For conventional piston-type engines, gasoline is expected to be refined up to 110 octane by 1960.

Some buses and trucks are already running on a new fuel called "LPG"

for short, or liquefied propane gas. Fuel-grade propane gas is a mixture of hydrocarbons, similar to natural gas. Propane gas is commonly found as the pressurized fuel gas in small hand blowtorches used for soldering purposes.

When liquefied, propane gas can be a highly efficient fuel if it is burned in properly modified internal-combustion engines. The gas burns clean with an almost invisible, odorless exhaust, forms very little engine deposit and does not burn the oil film on the cylinder walls.

Using LPG also saves considerable money. One bus company fueling their vehicles with the gas reports a saving of about $2,200 in fuel and upkeep on each bus.

Making use of better fuels, small size, better efficiency and light weight, industrial power plants of the future will be better fitted to deliver power efficiently and cheaply, with the minimum of maintenance.

More New Science Fairs

➤ FOURTEEN new regional science fairs have joined the National Science Fair and at least 20 more are planning to do so.

They will join 122 other regional and state fairs which will be sending their top winners to the National Science Fair in Flint, Mich., May 7-10, for nation-wide recognition.

While the country's top experts consider ways to discover and encourage more young scientists, thousands of youngsters are finding their own way. They are investigating everything under and including the sun and demonstrating their answers in colorful and dramatic exhibits for their local science fairs.

As more and more schools hold fairs, more regional fairs are organized to serve as focal points and meeting grounds for local fairs in their areas. An increasing number of these large fairs are becoming a part of the annual national competition coordinated by Science Service and planned as a mutually rewarding opportunity for high school-aged scientists, teachers, sponsors and professional scientists.

Among the largest of the new fairs will be the Harrisburg, Pa., Fair and the Metropolitan Detroit Science Fair, both sponsored by many top industries and community organizations. The Detroit fair will provide space for 2,000 exhibits at the Michigan State Fair Grounds. The mayor of Detroit, Albert E. Cobo, is honorary chairman and James C. Zeder, vice-president of the Chrysler Corporation, is chairman. Twenty-five top educators, industrialists and professional people are on the executive committee of the fair.

Other recently affiliated fairs include Atlanta, Ga.; Hammond, Ind.; Monroe, La.; Lowell, Mass.; Lansing, Mich.; Grand Rapids, Mich.; Cape Girardeau, Mo.; Minot, N. D.; Teaneck, N. J.; Plattsburgh, N. Y.; Readings-Bucks County, Pa.; and Colorado-Wyoming.

Batteries Operate at Temperature Extremes

➤ Two GROUPS of completely dry batteries that operate at vast temperature extremes have been described to a meeting of the Electrochemical Society.

One group of batteries designed for use in arctic regions operates efficiently at temperatures lower than 58 degrees below zero Fahrenheit. Another group, designed for use in electronic equipment, increases efficiency as the temperature is increased up to about 275 degrees.

Neither group of batteries contains any liquid or involves moving parts.

Ammonia For Cold Operation

The low temperature batteries contain compounds that can react with ammonia to form ammonium compounds with the release of electrical energy. The dry batteries are activated by the addition of ammonia gas, J. M. Freund of Eastman Kodak Company, Rochester, N. Y., said. He and H. S. Gleason, of Eastman Kodak, developed the batteries with the cooperation of Dr. L. J. Minnick and W. F. Meyers of G. & W. H. Corson, Inc., Plymouth Meeting, Pa., who discovered the method while developing a process for extracting metals from their ores.

Mr. Freund said the batteries can be tested by adding ammonia gas, and then deactivated for storage simply by removing the gas with a vacuum pump.

The scientists have used their batteries to operate lamps and small equipment at 58 degrees below zero Fahrenheit. Storage batteries were operated at 65 degrees below zero at the University of Michigan in 1951 as part of an Army Ordnance project. However, these were conventional liquid batteries with structural modifications.

Silver Iodide For Hot Work

The high temperature batteries reported by Dr. J. L. Weininger, General Electric Company research laboratories, Schenectady, N. Y., are based on silver compounds. The completely dry batteries are smaller and lighter than conventional liquid batteries of the same efficiency, Dr. Weininger said.

A major ingredient of the batteries, Dr. Weininger reported, is silver iodide. The compound increases its activity in the cell as the temperature of the battery increases. For purposes of operating photomultiplier tubes, scintillation counters and other electronic devices, the battery becomes more efficient with increasing temperature, Dr. Weininger said, and added that the new batteries could lead the way to development of thermocells. Such a device could be a power source that is normally non-producing, but is activated by heating it.

The use of chemicals in the control of plant diseases and insects is a widely accepted practice with successful growers.

Ultra high temperature pasteurization differs from the old methods in that the temperature used ranges from about 190 to 280 degrees Fahrenheit.

Most Desirable Girl of '58

➤ IF THE NATION'S schools and industries had a choice, the "Most Desirable Girl of 1958" would probably be the coed with a degree in mathematics.

Dr. Vern O. Knudsen, vice-chancellor of the University of California at Los Angeles, says:

"In 35 years, I have never seen such a demand for college mathematics."

The statistics back him up. Over the last three years, the number of UCLA undergraduate coeds majoring in mathematics has almost doubled, from 56 in 1954 to 104 currently enrolled. Overall enrollment for all students in the department is up 15% from last year.

But the increase is not nearly enough to satisfy the almost staggering demands of our schools and industries.

During the 1956-57 school year, the UCLA Office of Teacher Placement received 616 requests for teachers with backgrounds in mathematics. Only seven mathematics graduates, one a coed, were available to answer the demand.

Industry, although draining off the majority of mathematics graduates through more rapid promotions and salary increases than offered in teaching, faces a severe shortage of its own.

"We get a dozen or more requests for every man or woman we graduate," says Charles B. Tompkins, director of UCLA's Numerical Analysis Research, who trains coders and problem analysts for the mushrooming electronic computing field.

In other industrial and commercial fields the demand for mathematicians, as registered at the UCLA Bureau of Occupations, runs three times heavier than the available supply.

Salary discrimination against women, illegal in the California teaching profession, is rapidly disappearing in industry, as demand increases and women career mathematicians prove their professional skill.

Electron Microscope Aids Molecular Study

➤ THE ELECTRON microscope has revealed how fine particles, such as those found in smokes, proteins and bacteria, clump and grow, Dr. John Turkevich, Eugene Higgins professor of chemistry at Princeton University told the University of Louisville chapter of the Society of the Sigma Xi.

Dr. Turkevich, national Sigma Xi lecturer, told the chapter that the electron microscope has enabled science to bridge the chasm between the theoretically assumed molecule and what the eye can observe in detail.

Scientists, he said, now can obtain pictures of objects as small as ten angstroms, one angstrom being four-billionths of an inch long. The optical microscope, on the other hand, details only to 2,000 angstroms. The eye's resolution is about 1,000,000 angstroms.

Skin tone and facial detail, improved by proper lighting, are as necessary as dialogue in color TV.

Refresher Course for Teachers by Mail

➤ A NEW correspondence course in Advanced Inorganic Chemistry has been developed by the University of Wisconsin Extension Division, Madison, to meet the need for a refresher course for chemists and teachers in the field. The course is open for enrollments now.

Designed to bring out recent advances in the field, Chemistry 157 was developed by Dr. George Town, chairman of the Extension chemistry department. Inorganic chemistry is a special field of study for Prof. Town, who joined the University in 1923.

Upon successful completion of the three-credit course a student can satisfy the prerequisite for a number of other advanced chemistry courses offered in residence.

Theoretical topics in the 24-assignment course include: (1) the four quantum numbers and the periodic electron distribution; (2) ionic bonds, ionization and oxidation potentials, radii and the properties of ionic crystals; (3) the covalent bond, properties, hybridization and resonance; (4) acid-base theories; (5) magnetic properties of inorganic substances.

These modern theories will be applied to the descriptive chemistry of the regular, transition, and inner transition elements in terms of modern nomenclature.

Anti-Cancer Chemicals Are Still in the Future

➤ THE CHEMICAL CURE for cancer, although much closer than it was 14 years ago when the first chemical agents were tried, is still a long way off.

This was the tone of a transatlantic talk between British cancer specialists in London and American researchers attending the American Medical Association Philadelphia meeting.

One of the biggest problems is knowing when to give a drug up as a failure, Dr. Eve Wiltshaw, Royal Marsden Hospital, London, told the conference.

It is much easier to make the drugs than to try them out in humans, she said. If they have bad effects, the tendency is to throw them out. Nitrogen mustard, one of the most useful type of agents, would have been lost this way.

Dr. Emil Frei of this nation's National Cancer Institute, Bethesda, Md., told the transatlantic panel that we may be far from realizing the full worth of all the chemicals that we have right now.

The problems of understanding cancer and how to stop it will take scientists down to the very core of life itself, Dr. Leandro M. Tocantins, Jefferson Medical College, Philadelphia, and moderator of the conference, reported.

In this regard, Prof. A. Haddow, London University, said that he doubted whether any of the presently used drugs would find a permanent place in curing cancer. Their main importance, he said, is not in their practical use but in the light they shed on the whole cancer process.

Science Talent
Search Project

Comparison of Detergents, Soaps, Shampoos, Dentifrices

by MARJORIE KAY SIMILA
North Salem High School, Salem, Oregon

➤ MANY TIMES it has happened that, going into a store to buy a washing product of some kind, I would see before me innumerable brands, each one making fabulous claims of one kind or another, and all claiming to be the best. After carefully reading the labels, I would still be unsure just which product actually was best, and how true were the claims made. Making an investigation to find out these things appealed to me, and with the help of the school and some of my dad's old chemistry books, I was able to carry out the project.

Originally my purpose was to analyze all soap flakes, detergents, shampoos, and toothpastes now on the market. However, it soon became apparent that this would become much too involved, and so I limited my samples to those commonly used in our home. They are, (1) detergents: Tide, Woolfoam, and Cheer; (2) soap flakes: Woolite, White Magic, and Boraxo; (3) shampoos: Mennen, Prell, Pamper, Glo·ver, Blondex, Vaseline, and Palmolive; and (4) toothpastes: Colgate, Papaya (tooth powder), Squibb Dental Creme, and Sheffield. Following this report are charts showing the exact results I obtained. Occasionally, due to lack of equipment, or inexperience, I got results which are at best inconclusive; therefore I cannot derive positive conclusions from them. Here are some positive results I did get.

Detergents

Of the three detergents I tested, Woolfoam had the lowest pH (6.5) while Tide and Cheer were both alkaline with a pH of 7.5 each. The three were practically equal in suds-producing action, all three being very effective. None of the three formed curds in hard water. To find the tolerance to oil and grease, I doubled the amount of detergent necessary to make a good suds and added oil drop by drop, shaking after each drop, until the suds were destroyed. Woolfoam tolerated the most oil, Cheer was next, and Tide came last. However, Tide still tolerated a considerable amount in proportion to the amount of detergent used.

Soap Flakes

Of the three soaps used for this comparison, White Magic had the lowest pH (6.5), Woolite was neutral, and Boraxo was alkaline with a pH of 7.5. In suds-producing action, all were efficient and very close in ability to the detergents. Woolite formed no curds in hard water, but both White Magic and Boraxo formed a considerable amount. Oil tolerance was close

➤ MARJORIE KAY SIMILA, *18, Salem, Ore., decided to ignore advertising claims and find out for herself which of the many household products on the market she should buy. Her curiosity led to a project that helped her become one of the top winners of the 16th Annual Science Talent Search for the Westinghouse science scholarships and awards. The 17th Annual STS, conducted by Science Clubs of America and administered by Science Service with the support of the Westinghouse Educational Foundation, climaxes Feb. 27 - Mar. 3 with the participation of the 40 top winners in the Science Talent Institute in Washington.*

to equal for all three, and was noticeably less than that of the detergents.

Shampoos

The shampoos I tested were seven in number, so the results of this comparison are probably more representative than those of the other comparisons. Vaseline shampoo had a pH lower than that of any product thus far mentioned — between 6.0 and 6.5. Mennen and Prell shampoos were neutral. Slightly alkaline were Pamper, Glo·ver, Blondex, and Palmolive. An interesting coincidence in relation to sudsing action is the seeming advantage possessed, in general, by the neutral-acid shampoos over the alkaline ones in the group I tested. Also it happened that the only opacity or curd formation in hard water was found in alkaline shampoo samples. There was a great variation in oil tolerance. Pamper and Vaseline were high, Mennen and Glo·ver low. I observed that Blondex shampoo, unlike the others, divided the oil into particles so fine that the general color was lightened. This would perhaps speak well for its cleaning power.

RESULTS OF SOAP COMPARISONS

Brand Name	Description	pH	Distilled[1]	Hard[2]	Cloudiness, if any	Oil Tolerance[3]
Woolite	Cold water soap for wool	7.0	7	18	Slight opacity	10 drops oil / 14 drops soap
White Magic	Soap flakes with detergent qualities	6.5	4	11	Great curds	14 drops oil / 8 drops soap
Boraxo	Powdered hand soap	7.5	7	46	Very great curdling and cloudiness	8 drops oil / 14 drops soap

[1] Number of drops of a 2% soap solution necessary to produce good suds in 10 ml. of distilled water.

[2] Number of drops of the same solution necessary to produce good suds in 10 ml. of permanent hard water.

[3] Number of drops of oil necessary to destroy suds (in distilled water).

COMPANIES OF BRANDS TESTED — Woolite, Honey Harbour Co., Ltd., New York & North Hollywood; White Magic, Newport Soap Co., Oakland, California; Pacific Coast Borax Co., division of Borax Consolidated, Ltd., New York & Los Angeles.

RESULTS OF DENTIFRICE COMPARISONS

Brand Name	Description	Carbonate	Abrasives	Starch	Borate[1]	Borate[2]	Chlorate	Potassium
Colgate	Cleans breath Guards teeth	Small amount	None	None	None	None	None	Positive
Papaya Tooth Powder	Non-abrasive	Great amount	None	Considerable amount	None	None	None	Positive
Squibb Dental Creme	Alkaline Safe	Very great amount	None	Slight amount	None	None	None	Positive
Sheffield	"Special formula 35"	None	None	None	Positive	Negative	None	Positive

[1] Flame test. [2] Turmeric paper test.

COMPANIES OF BRANDS TESTED — Colgate, Colgate-Palmolive, New York; Papaya Tooth Powder, Frenco Laboratories, Nogales, Arizona; Squibb Dental Creme, E. R. Squibb & Sons, Div. of Olin Mathieson Chemical Corp., New York; Sheffield, Sheffield Co. Manufacturing Chemists, New London, Conn.

RESULTS OF DETERGENT COMPARISONS

Brand Name	Claims	pH	Distilled[1]	Hard[2]	Cloudiness if any	Oil Tolerance[3]
Tide	Good cleanser Safe for hands	7.5	6	14	Slight opacity	26 oil / 12 soap
Woolfoam	Wool wash Contains no soap, oils or fats.	6.5	6	3	Almost clear	95 oil / 12 soap
Cheer	Cleans and whitens.	7.5	4	5	Almost clear	8 soap / 46 oil

[1] Number of drops of a 2% solution necessary to produce good suds in 10 ml. of distilled water.

[2] Number of drops of the same solution necessary to produce good suds in 10 ml. of permanent hard water.

[3] Number of drops of oil necessary to destroy suds (in distilled water).

COMPANIES OF BRANDS TESTED — Tide, Proctor & Gamble; Woolfoam, Woolfoam Corp., New York; Cheer, Proctor & Gamble.

Tooth Pastes and Powders

The dentifrices I analyzed were: Colgate tooth paste, Papaya tooth powder, Squibb Dental Creme, and Sheffield tooth paste. They all were similar in that I found no evidence of abrasives in any of them, and likewise no borates or chlorates. They all contained potassium compounds. Papaya tooth powder and Squibb Dental Creme contained considerable amounts of carbonates. Colgate contained only a small amount, and Sheffield none at all. Papaya tooth powder contained a considerable amount of starch, which isn't surprising since it is advertised as being derived from the papaya plant. The tooth pastes showed little or no reaction in the starch test.

The methods I used to obtain the above results were in general those outlined in *Discovery Problems in Chemistry**. There were variations due to convenience or necessity, and in order to find several of the specific tests I had to consult many other books. My procedure was much the same for the soaps, detergents, and shampoos. Soap and detergent solutions were 2% (by weight) and shampoo solutions were 10%. The pH of each soap and detergent was determined from the weakest possible solution that would support suds, while the pH of shampoos was determined from the 10% solution. In other respects the method was the same for all. For the dentifrices I adhered more strictly to the method outlined in *Discovery Problems in Chemistry,* omitting the phosphate test and using both the flame test and turmeric paper test for borates.

I was rather surprised, as the work progressed, to find how many differences there are among the various brands. They usually look different, of course, but the similarity of claims

* Eckert-Lyons-Strevell; College Entrance Book Company.

made about each one, and the widespread advertising of each had led me to suspect that they might all be no more than individual variations of the same basic product. This project has been a real eye-opener in that I found many similarities, but also many differences. Some soap solutions were clear and colorless, others cloudy or colloidal. Some were denser than others, some more odorous, and one shampoo (Blondex) formed a gel.

The more I explore this field, the more I marvel at the ingenuity of the men who derive these ways of making their product attractive to the public. Although this series of tests is completed, I find that there is more I would like to know about these products now than before my tests were started. Reading on this subject has widened my knowledge of chemistry greatly. More than anything else, I think, this study has shown me how very much fun an organized exploration in chemistry can be.

RESULTS OF SHAMPOO COMPARISONS

Brand Name	Description	pH	Distilled[1]	Hard[2]	Cloudiness, if any	Oil Tolerance[3]
Mennen	Soapless, non-alkaline Contains lanolin	7.0	5	2	Almost clear	14 oil / 10 shampoo
Prell	Radiant shampoo	7.0	1	2	Almost clear	65 oil / 2 shampoo
Pamper	Gentle	7.5	2	4	Almost clear	88 oil / 4 shampoo
Glo·ver	Can be used in hard or soft water	7.5	5	31	Some opacity	15 oil / 10 shampoo
Blondex	Shampoo for blondes	7.5	5	17	Small curds	38 oil / 10 shampoo
Vaseline	Soapless shampoo Needs no special rinsing	6.0-6.5	2	1	Almost clear	75 oil / 4 shampoo
Palmolive	Non-drying	7.5	8	32	Opaque	41 oil / 16 shampoo

1 Number of drops of a 10% shampoo solution necessary to produce good suds in 10 ml. of distilled water.

2 Number of drops of the same solution necessary to produce good suds in 10 ml. of permanent hard water.

3 Number of drops of oil necessary to destroy suds (in distilled water).

COMPANIES OF BRANDS TESTED — Mennen, Mennen Co., Morristown, N. J.; Prell, Proctor & Gamble; Pamper, Gillette Co., Chicago, Ill.; Glo·ver, H. Clay Glover Co., Inc., N. Y.; Blondex, Swedish Shampoo Laboratories, New York; Vaseline, Chesebrough Mfg. Co., Cons'd, New York (distributor); Palmolive, Colgate-Palmolive Co., Jersey City, New Jersey.

A U.S. Scientist Does Not Agree on Russia

➤ THE RUSSIANS are not ahead of the United States in basic research.

A majority of Russian scientists are poorer paid than their American counterparts and tales of their pampered life have been exaggerated.

Actual discoveries by Russia's nuclear physicists in basic science are not impressive.

These are some of the conclusions drawn by Dr. Donald J. Hughes, a senior physicist at Brookhaven National Laboratory, Upton, N. Y., after a recent month's tour of Polish and Russian nuclear laboratories as a guest of the Soviet Academy of Sciences.

He is optimistic about the future and even points out that because of the different ideologies in the U. S. and the U.S.S.R. "there is little danger that the Soviets will pass us up in basic science."

Poles Want Western Aid

In Poland, Dr. Hughes found the Polish nuclear scientists looking for the West's help in science; anxious to receive Western research equipment; and having a high opinion of Western science as the world leader in fundamental research. He also found anti-Russian feelings widespread from the "man-in-the-street to the intelligentsia."

In Russia, Dr. Hughes found the only Red scientists to be socially pampered were the relatively few Academicians. The greater majority of scientists, he says, receive about half the pay of American scientists in real purchasing power and do only half as well in their standard of living as our scientists.

Although the Russians excel largely in the field of large equipment, they are definitely lagging far behind the United States in many areas of basic research.

Speaking of the world's largest accelerator, which the Reds have at Dubna near Moscow, the Soviet atomic power plant and the sputnik, Dr. Hughes has this to say:

Money, Not Brains

"In each of these cases the Soviet high command has picked the particular development and has pushed it ahead without regard for cost or manpower. These developments, however, are not basic science and are the type of things that can be pushed to rapid success if funds are not limited."

He cautions the U. S. from adopting the same practice. The Academy of Sciences, he says, rules all science, engineering and technology in the Soviet Union with an iron hand. Dr. Hughes explains, too, that Red scientists are friendlier to the West than the Academy.

Dr. Hughes says that under the present Russian set-up it is hard to see how basic science can advance. There is some evidence of change taking place, he notes, concluding, however, that:

"But my own opinion is that the difficulties go so deeply into the fundamental structure of the Soviet society that it would be impossible to gain the freedom of research so necessary to progress without a change in the Soviet Government more deep-seated than we can anticipate for decades."

Dr. Hughes' full report on his trip appears in the journal *Physics Today* (Dec.).

Special Carbon Causes Giant Star Darkness

➤ The mysterious darkness of the rare giants called carbon stars has apparently been explained by two University of California scientists who simulated part of the giants' atmospheres in the laboratory.

The gigantic objects, which have an excess of carbon, measure a hundred times the diameter of the sun or more. They appear to be much hotter than the sun at the center. Yet their ultraviolet light, a natural component of all light sources, is so weak as to be nearly undetectable.

Searching for a reason for the darkness, Dr. John G. Phillips, astronomer, and Dr. Leo Brewer, chemist, heated up materials in a tiny electrical furnace. Dr. Brewer is a pioneer in chemistry at high temperatures, where strange and new chemical compounds are created.

Low Temperatures Hot Enough

While the laboratory temperatures reached, 2,000 to 3,000 degrees centigrade, correspond only to the temperatures of the atmospheres of the cooler stars, they were high enough to create bizarre molecules of carbon, especially one in which three atoms of carbon are linked.

The spectrum of this carbon molecule, which does not exist at ordinary temperatures, corresponded to a very strong carbon spectrum found in the giant stars.

The existence of large quantities of this molecule in the atmospheres of carbon stars could account for absorption of most of the ultraviolet light, explaining the great weakness of this part of the spectrum, the scientists said.

Producing Galaxy Changes

The carbon stars are of particular interest because, in addition to having an excess of carbon, they appear to be "factories" of heavy elements that may be changing the chemical composition of the galaxy.

The enormous heats at the centers of the carbon stars, approaching a hundred million degrees absolute, generate neutrons which are added to lighter elements in successive nuclear transformations. The resulting heavy elements apparently are eventually spewed into space through diffusion or explosion, with the possibility that the chemical composition of the galaxy may be changing in the direction of a gradual increase in the heavier elements.

An altitude simulator laboratory and a special high-altitude pressure suit recently made it possible for a scientist to go up to a 95-mile altitude without actually leaving the ground.

It is no longer possible to stock-pile strategic weapons before they become obsolete.

Scientists are developing a furnace to test plane and missile components at 12,632 degrees Fahrenheit.

A modern jet bomber may require as many as 2,000 electronic tubes.

Impurities May Slow Peaceful H-Bomb Progress

➤ A NEW PROBLEM in harnessing the hydrogen bomb's fiery reactions for peaceful purposes was suggested to the American Physical Society meeting at Stanford, Calif., by Dr. Richard F. Post of the University of California's Radiation Laboratory in Livermore.

The problem is impurities in the experimental gases, usually hydrogen, which scientists are now using in experiments aimed at taming the energy of fusion for controlled power.

The impurities in hydrogen gas and the difficulties they cause can be likened to the impurities in uranium impeding the progress toward controlled atomic fission in the early experimental work in that field. Before the first atomic pile could be built, indeed before it could even be considered a possibility, scientists had to make extensive measurements on uranium of a purity then undreamed of.

Dr. Post reported that only a small percentage of impurities in the hydrogen gas with which scientists are now experimenting in their attempts to control fusion would result in a great increase in unwanted radiation at the high temperatures necessary.

What scientists want to get from the thermonuclear process is extra neutrons, which will be formed only at temperatures of several million degrees. Reports that these extra neutrons have been achieved by the British recently and by the Russians about a year ago could be true, yet the neutrons could be of a "bad kind, not a good kind," Dr. Post said in an interview. The bad kind would be unwanted, interfering with the desired process.

At temperatures required to attain nuclear fusion, in the neighborhood of hundred million degrees centigrade, hydrogen turns into an electrically charged gas called a "plasma." Dr. Post reported on radiation process in a high temperature plasma and how the technical problems encountered in experimental work in this field influence the course of future research.

The side effects caused by impurities in hydrogen may be important in future experiments on harnessing extremely high temperature reactions, Dr. Post said.

New Hard Glass for Labware

➤ A NEW ULTRA-HARD glass for high temperature applications has been developed. Already being used in production of laboratory and scientific equipment, the new glass has a softening point of 820 degrees Centigrade, almost as high as the melting point of silver and appreciably higher than the melting point of aluminum. Glass-measuring equipment will remain accurate over wide temperature ranges because of a very low coefficient of expansion.

The new glass, designated KG-33, was developed by Kimble Glass Company, subsidiary of Owens-Illinois Glass Company.

High-Speed Photos Aid Study of Bubbles

➤ HIGH-SPEED photography is showing that the size and shape of bubbles and drops become important in the liquid-liquid or gas-liquid contacts that are so necessary in making such products as gasoline, rayon, asphalt, dynamite, DDT and even maraschino cherries.

Dr. Robert C. Kintner, professor of chemical engineering at the Illinois Institute of Technology, has been using high-speed photography to study bubbles and drops. He is interested in their shapes and speeds in relation to size, the effect the surrounding fluid has on them and the role surface-active agents and impurities play in their size, shape and internal structure.

Odd Shapes in Gases

A large variety of shapes has been discovered in gas bubbles. Besides spherical ones, there are flattened spheres, ellipsoidal bubbles, "cap-shaped" spheres and even "inverted tear-drop" shaped bubbles, formed in special liquids. Liquid drops of tear-drop shape have been found to leave behind a fine "vapor trail" of tiny droplets of mist.

Dr. Kintner observed that surface-active agents much like laundry detergents hinder circulation within the drops or bubbles, slow them up in their travel and prevent them from merging into larger bubbles or drops. Impurities in the surrounding fluid tend to concentrate in the interface between close-packed drops or bubbles, and as as "shields" to prevent them from merging, behaving like the surface-active agents. Almost any impurity can act this way, Dr. Kintner concluded.

High-Speed Photos Necessary

Certain phenomena shown by bubbles and drops can only be discovered by using high-speed photography, said Dr. Kintner. The observations will be used to construct mathematical equations that can "predict" the way the drops or bubbles will act, thus helping to increase the efficiency of processes which have to make use of bubble and drop phenomena.

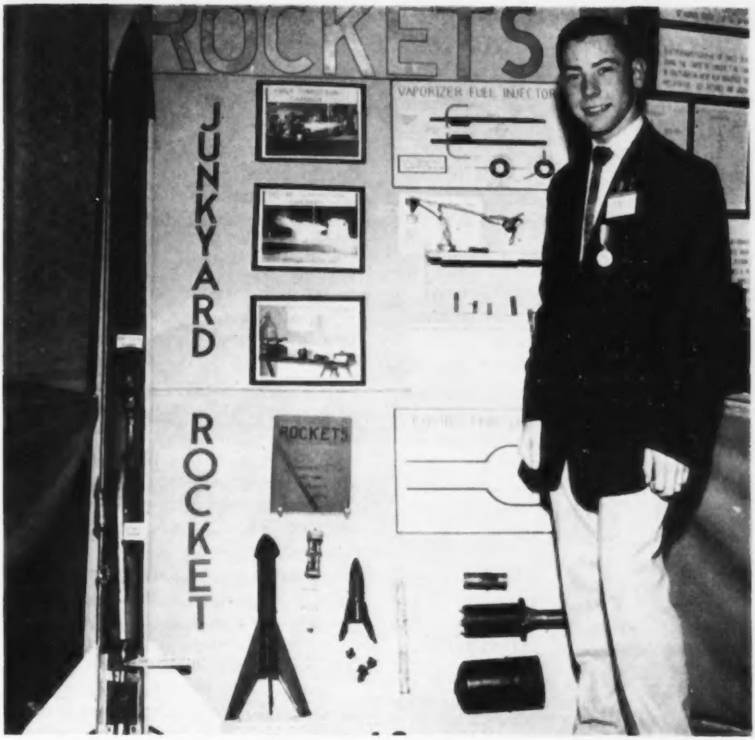
Sound Waves Improve Plating

➤ BRIGHT CHROMIUM plating is improved by passing sound waves through the plating solution.

Joseph S. Dereska of National Carbon Company Research Laboratories, Parma, Ohio, told an Electrochemical Society meeting that sound waves make the chrome plate harder, stick better to the base metal, increase brightness and make the plated surface less porous. Mr. Dereska said the effects were only slight, but definitely beneficial.

Waves of 10 kilocycles per second, sonic, and 260 Kc. per second, ultrasonic, produced essentially the same effect. Mr. Dereska believes the sound wave vibrations have the effect of agitating, or stirring, the plating solution at the surface to be plated.

AMATEUR ROCKETRY



➤ Youngsters *all over the nation are devising safe, non-explosive and challenging rocketry projects. William P. Love, 18, Tallahassee, Fla., called on all his project skills in making this National Science Fair display which shows his own design of a liquid fuel rocket which utilizes fuel injection and eliminates pressurized tanks.*

A CHEMISTRY SPECIAL SECTION

Safety Must Be Stressed

Rocketry Amateurs Need Supervision

➤ YOUNGSTERS must stop performing the kind of rocket projects that have made recent news before the young experimenters and innocent bystanders are killed or injured.

There are safe projects, not involving explosive mixtures, that can be carried out by well-supervised students who are more interested in learning rocket science than in watching a fireworks display.

These are the views of the outgoing president of the American Rocket Society, the director of the Pentagon's Division of Strategic Missiles, and military and civilian rocket engineers and chemists.

Rocketry, including amateur efforts, has become so advanced that student enthusiasm must be directed away from mixing fuels and firing rockets and channeled into the more important study of theory, say Cmdr. Robert C. Truax, retiring president of the ARS, and Donald W. Patterson, director of the Division of Strategic Missiles of the Office of Guided Missiles.

Both these officials have prohibited their own teen-age children from carrying out conventional rocket projects and have encouraged them to carry on their investigations in safer fields.

Steam-Powered Rocket

Cmdr. Truax, Ballistics Missiles Division, Air Research and Development Command, Inglewood, Calif., recently analyzed and suggested a safe, but powerful, steam-powered rocket that eliminates mixing and transporting explosive fuels. He told CHEMISTRY the amateur rocket, which should reach altitudes of five to ten miles, resulted from a desire to protect his 15-year-old daughter and her young friends who are rocket enthusiasts.

"If they fool around with stove pipes, copper tubing and explosives," he said, "they are going to blow their heads off."

The rocket would consist of a metal shell similar to those used for explosive-filled rockets, but contain water and an empty space in which steam builds up to supply pressure for thrust. The shell is fitted with a nozzle and plug, stopcock or automatically popping safety valve set for high steam pressure. It would be launched from a ramp containing a heater to convert the water to steam.

No "Completely Safe" Rocket

Cmdr. Truax warns that a possible danger still exists if the rocket is constructed by a person who is not aware of the shell strength needed to withstand a given steam pressure. The shell could rupture and injure nearby persons not protected by barricades.

"In this sense no rocket, not even one powered by steam, is completely safe," the rocketry expert said, adding that persons launching any type of rocket should always be protected by barricades.

Mr. Patterson told CHEMISTRY: "It is inconceivable, in view of the

top talent and almost unlimited facilities available to our rocket and missile program, that an amateur effort would result in any worthwhile design or fuel formulation not already considered officially, but I think student and amateur efforts must continue and their support is justified on the basis of training future scientists."

Must Learn Basic Science

However, Mr. Patterson said, for this training to be worthwhile it must be in science fundamentals and basic rocketry techniques, and should not be allowed to "degenerate into fireworks displays." The principle of rocket reaction, he said, can be demonstrated by releasing air from a balloon.

Serious projects that will teach fundamental rocketry can be performed with small carbon dioxide bottles, relatively safe solid rocket fuel pellets and other materials available at hobby shops, Mr. Patterson said.

"One of my three sons wants to be a rocket scientist and I hope to keep him alive long enough to realize his ambition," Mr. Patterson said, adding that he thinks his son is learning as much from safe projects as other boys are learning from dangerous home-made rockets.

Where Can Rockets Be Fired?

➤ THE QUESTION of where student and amateur rocketry groups can fire their home-made rockets has been answered by spokesmen for the Armed Services.

All three military branches are encouraging well-supervised rocketry groups at local levels and such groups will be welcome at many military installations. However, there are some strings attached.

Groups requesting permission to launch rockets from military bases must be well organized under the close supervision of competent persons, and must demonstrate a bona-fide interest and knowledge in the fields of science that comprise rocketry.

Amateur groups merely wanting to "put something in the air" or conduct "fireworks displays" can expect to be denied permission to use military facilities by local base commanders upon whose authority the decisions rest.

Tracking Gear Is Out

Students and amateurs must not expect the use of military tracking facilities and personnel. About all a local commander can offer is safe space and any barricades that might exist, such as those found on a rifle firing range. However, space and barricades are the two most elusive items on a rocket club's "must" list.

In all three services the decision to deny or admit rocketry groups to military bases must be made by the base commander. None of the services has an overall policy on the matter, but each is committed to maximum cooperation with local civilian groups.

However, such cooperation must conform to the nature of the post. For example, an installation that does not have firing space available cannot be expected to create such space, nor can the local commander be expected to alter his unit's training cycle or

testing work just to make facilities available to civilian groups.

The Army comes closest to a formal general policy in its Army Regulation 360-55, which authorizes commanding officers to develop and promote ways in which members of their commands can participate in local civilian activities.

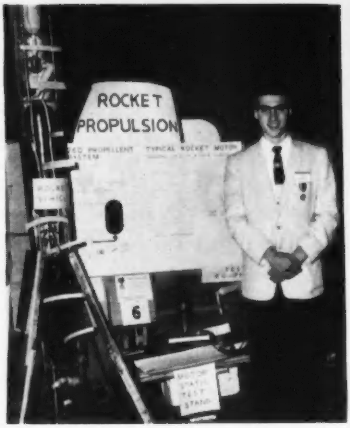
By direction of Congress, the Army cooperates, even to the point of some financial subsidy, with such groups as the Boy Scouts, Civil Air Patrol and National Rifle Association. So far there is no Congressional directive covering rocketry groups, but Pentagon spokesmen feel the spirit of the law is sufficient authorization to cooperate without financial aid.

Army spokesmen said well-supervised rocket clubs conducting planned programs for scientific knowledge already have been allowed to fire from many posts. Even the security-conscious White Sands, N. M., installation has welcomed amateur groups during free time from military projects and after ample notice to security officers.

Air Force and Navy commanding officers operate under general policies of "cooperation with the public," but at present do not have any clear-cut directives concerning rocket clubs. However, spokesmen for both services said that qualified rocket clubs should have no difficulty in obtaining permission to use any facilities that might be available.

Don't Request Cape Canaveral

The Navy says the question has never been posed at a high level, and that local commanders should be willing to cooperate under the same authority that permits cooperation with Sea Scouts.



➤ A ROCKET *this size requires a lot of safe range space. Theodore John Panayotoff, 17, Mobile, Ala., shown here with his National Science Fair project, does not fire a rocket until after it has been safely tested on a static test stand.*

The Air Force makes it clear that amateur rocket groups should not expect to use the guided missile test facilities at Cape Canaveral, Fla.

Recently, the American Rocket Society endorsed a plan calling for more military bases and Federally controlled land to be made available to qualified groups for supervised firings. The plan, which covers a broad program of Federal aid besides permission to use land, was sent to the Department of Defense, the National Science Foundation and the National Committee for the Development of Scientists and Engineers.

Use Chemical Knowledge
For Better Projects

Rocketry Project Ideas

by David Pursglove

➤ The young chemist who is interested in rocketry often feels a lack of challenging and stimulating chemistry rocketry projects. He has been advised against compounding rocket fuels, not only because of the danger involved, but also because the mere mixing together of zinc and sulfur or potassium chlorate and sugar hardly constitutes a challenging project that will test his skill and add to his knowledge.

The design, building and firing of a rocket "just to get something in the air" is a shameful waste of his interest in chemistry and a waste of time that could be used in studying the chemical implications of rocketry.

Rocketry Needs Chemistry

Aside from devising fuels to meet exacting specifications, chemists must work constantly to supply designers with exotic new materials and volumes of specialized data.

They create structural materials that will withstand the shock of takeoff, the heat of air friction, the bombardment of cosmic rays and the shattering effects of extremely low temperatures. They develop greases and lubricating agents, battery electrolytes and electrical insulations, magnetic tapes and transistors that will withstand all the abnormal conditions imposed by rocket flight. They develop nose cones that will withstand the tremendous temperatures of atmospheric re-entry.

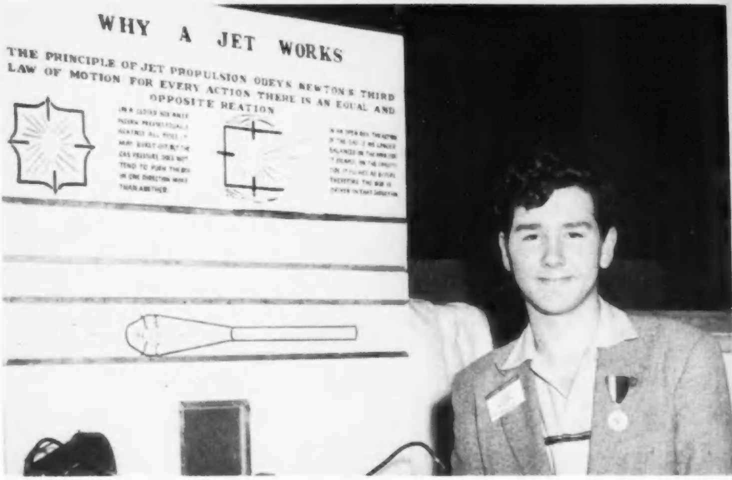
Chemists analyze the make-up of the upper atmosphere and outer space and gird themselves for the problems to be imposed on them by faster travel farther into space.

These are the real challenges faced by today's chemist as he steps into the rockets and missiles field. This is the work today's young chemist — the student and the amateur — wants to get into. But, he asks, can this type of research be conducted in *my* lab? The answer depends, of course, on the student.

The Library First

Talk with a few chemists in research or development. Ask them where they spend most of their time. You will find that the laboratory bench occupies only a small part of their time, that their toughest work — that which brings the widest range of their knowledge into action—takes place in the library and conference room. The library and the research group conference generates the hypotheses that are later confirmed in the laboratory.

Such must be the case also with the young chemist entering his first research venture. Before stepping foot into the laboratory he must study his field: learn the basis for the reaction that is to take place later in the laboratory, understand the mechanism and kinetics of what he hopes to accomplish, be familiar with the equilibria that must exist if he is to ac-



➤ FUTURE HELICOPTER *and jet engine designer Jimmy Lewis Wilson, 17, Levelland, Tex., said he found "a lot of library reading" important in planning his National Science Fair project, a working model of a jet engine he designed and a discussion of theory behind jet operation.*

complish his goals. Be so familiar with the field that you will be able to predict in advance, on paper, exactly what will happen in the lab.

If the experiment should fail to meet the well-founded prediction, you have made a discovery. Be able to recognize it for what it is and follow through on it.

Although a few fields for fruitful literature searching are mentioned in connection with the following project suggestions, many are purposely omitted. The research chemist must be imaginative and self-reliant to the extent of designing and conducting his own literature searches. It should also be pointed out that the following suggestions are not intended to represent complete projects, but are offered only to stimulate the student's imagination in planning his own projects.

Combustion Products

Some of the fuels used in today's rockets, and most of those used in jet aircraft, are hydrocarbons which are burned in the presence of oxygen. The mechanism and kinetics of this reaction are similar to the burning of many more advanced fuels. Combustion chemists have developed means of controlling flames so combustion can be studied accurately and more easily. Usually a flat, or "laminar," flame is produced under reduced pressure or between charged surfaces. It is then possible to insert tiny instruments into various parts of the flame for purposes of measuring temperatures in different portions or withdrawing gas samples.

By means of a small thermocouple (designing and building this is an interesting project in itself) the student

may wish to measure temperatures in various parts of a flame. Although the laminar flame is better suited to the study, it can be carried out on a Bunsen burner or kitchen range flame.

If a laboratory burner is available and you have access to various bottled gases, or can generate several gases, an interesting project could consist of charting the "hot" and "cool" locations in flames of several gases and in varying proportions.

In theory, when a hydrocarbon is burned the products of combustion are carbon dioxide and water. In practice, the combustion is not complete and other products are also formed. You can design apparatus to collect combustion products from your flame. Measure the volume of combustion product at atmospheric pressure. Introduce into the container adsorbents or absorbents selective to CO_2 and H_2O. How much of the combustion product is some other material?

Using very tiny pipettes which you probably will have to make of metal, draw off samples of unburned gases from various parts of the flame. Determine the nature of these gases. Perhaps your project could be to try to determine why these gases have not burned and what could be done to make them burn.

Alloys

Chemists are constantly improving the building materials used by rocket engineers. A good place to begin your literature search toward improvement of existing alloys might be Dec., 1957 CHEMISTRY, p. 38.

The study and development of alloys requires high temperatures. Reasonably high temperatures can be achieved with home-made arc furnaces or oxy-hydrocarbon or oxy-hydrogen torches. However, these are not recommended for three good reasons: they can be dangerous, costly and inefficient.

A good project preliminary to your study of alloys would be the construction of a solar furnace. These can be built from commercially available lenses and mirrors, or from kits that are on the market. Students have achieved temperatures up to 3,000 degrees F in home-made solar furnaces.

"Living Wall"

Someday men and animals will be making long flights into space. There are many problems yet to be solved and among them is the problem of storing oxygen for breathing and getting rid of waste products.

At various times people have offered this suggestion: "Why not construct the living chamber of a rocket or space station of a material that will release into the room molecular oxygen as it absorbs carbon dioxide?"

The idea is not far-fetched and the basic reaction which gives rise to the idea can be studied by the student chemist. Such a material may take the form of a refractory based on an alkaline earth metal.

In several good general chemistry texts check the reactions involved in the hardening of plaster. The initial stages of setting are due largely to simple drying, but the actual hardening is due to the reaction of the plaster with carbon dioxide of the air: $Ca(OH)_2$ plus CO_2 yields $CaCO_3$ plus H_2O. The plaster as it is mixed is simply calcium hydroxide (slaked lime, $Ca(OH)_2$) which is a powder. After reaction with atmospheric carbon dioxide it becomes calcium car-

bonate ($CaCO_3$), a hard material. This is similar to the reaction of the "limewater" test for CO_2.

A careful study of alkaline earths, carbonates, oxides and commercial refractories should point the way to many interesting projects that could culminate in later-years-research on the problem of the "living wall."

Do not forget that your spaceship passenger involves more than oxygen and carbon dioxide. Give thought to nitrogen, water vapor and other needs and products of life.

Free Radicals

The Defense Department, other government agencies and some private organizations are interested in using free radicals to power future rockets and missiles. Already chemists have a pressing interest in their effects on structural materials, for they abound in the upper atmosphere.

Free radicals are produced at the National Bureau of Standards by dissociation of gases passing through strongly heated tubes or electrical discharges. They are frozen and studied. The NBS "freezes" its free radicals by directing the gas tube toward the outside wall of a container of extremely cold liquid helium, nitrogen, oxygen or other sufficiently cold liquified gas.

Although liquid helium is not available at the corner drug store, many liquified gases are available from suppliers in most large cities. Students who plan to try their hands at free radical research should be prepared to spend more than the usual amount of project money, not particularly for the liquified gases, but for the Dewar flasks in which to store them.

The student who has not studied free radical literature carefully should not expect his experiments to succeed. Although a capsule description of the Bureau of Standards' technique sounds simple, it is actually a very complex, time-consuming process and probably should be attempted only by the well-financed, expertly-supervised chemistry club. Even then attempts at trapping free radicals will necessarily be crude.

Do not forget that the project suggestions in this article are published only to stimulate the young chemist to developing his own projects. Each of the fields covered — combustion, alloys, "living wall" and free radicals — offers many easier-to-perform projects that should both challenge and teach.

Amateur Rocketry Do's and Don'ts

➤ Youngsters who feel the urge to build and fire rockets in spite of expert warnings should stick to tested materials available in hobby shops and leave gas pipes and explosive chemicals alone, professional rocket scientists warn.

Rocket engineers and chemists agree their best advice for the youngster is to forget about home-made rockets until he has learned all he can from less spectacular, but safer, projects.

However, the professionals, perhaps recalling their own younger days which now make them wonder how they are still alive, pessimistically agree their advice will be ignored by

many students, and offer these safety precautions:

Obtain close supervision from a competent person. Just because a person is a scientist, the rocket experts say, there is no assurance he is thoroughly familiar with explosives, gas expansion and properties of rocket materials.

Plan each project carefully well in advance of the firing date. Such planning enables experimenters to foresee and overcome difficulties. Also, by knowing the detailed needs of the project, youngsters will have plenty of time to locate safe materials and will not have to make hasty substitutions of unsafe material.

Choose Pipe Carefully

Do not use stove, water or gas pipe for rocket casings. Some of this pipe is designed to hold up under steady pressure, but will burst under sudden pressure or heat. Nearly all pipe commonly available is made with a seam, sometimes hidden, that splits under explosive force. Seamless pipe, which is usually more expensive and harder to locate, must be used.

Distinguish between explosives and rapid-burning fuels. Gun-powder is an explosive — solid propellants in military rockets are rapid-burning fuels, even though to the casual observer they appear to act explosively. Remember that nearly all rapid-burning fuels are explosives under certain conditions. Learn the conditions. Mixtures of potassium chlorate or potassium nitrate and sugar, powdered zinc and sulfur, powdered aluminum or magnesium and oxidizing agents are always dangerous explosives when ignited in confining containers.

Always fire even "safe" rockets by remote control from behind barricades. All persons in the area must be sheltered. Even a "safe" rocket carrying a light load in a strong container can tip or be pushed by a breeze at the last minute to fire in the wrong direction.

Ranges and Fireworks

Find a safe range. Even if the rocket fires safely, without exploding, it must come down somewhere. Make sure the range is long enough to accommodate the rocket on its most successful flight, and wide enough to permit deviations from the course caused by breezes or even the smallest warps in fin surfaces.

Make sure local laws permit rocket firing. Some rocketry experts believe legal authorities have every right to call amateur rockets fireworks and ban their use wherever fireworks are banned.

Do not use actual rockets for clubroom or classroom demonstration of rocketry principles. Use balloons or carbon dioxide bottles. In this connection, do not try to improvise from "empty" aerosol cans such as are used for shaving lather, house sprays or whipped cream.

Avoid the use of home-made rockets in projects wherever possible. For example, in testing the flight characteristics of a new fin design, use a small hobby-shop rocket — there will be one less chance of an accident.

Plan projects sccientifically to gain scientific knowledge. Such a procedure often shows that the building and firing of a rocket can be eliminated, but the information still gained through safer means.

Book Condensations

ATOMS AT YOUR SERVICE — Henry A. Dunlap and Hans N. Tuch — *Harper.* 167 p., illus., $3.50. A primer for the layman on nuclear physics and the remarkable ways in which atomic energy can serve the needs of industry, agriculture, and medicine.

THERE'S ADVENTURE IN CHEMISTRY — Julian May — *Popular Mechanics Press,* 156 p., illus. by Frank C. Murphy, $2.50. With his father a teenager discovers the secrets of chemistry.

CHEMISTRY OF ORGANIC COMPOUNDS — Carl R. Noller — *Saunders,* 2nd ed., 978 p., illus., $9.00. In this new edition, old material has been revised and new material added.

ELECTROCHEMISTRY: Principle & Applications — Edmund C. Potter — *Cleaver-Hume Press (Macmillan).* 418 p., illus., $10.00. An introductory text for the technology student.

PHYSICO CHEMICAL EXPERIMENTS— Robert Livingston — *Macmillan,* 3rd ed., 273 p., illus., $4.50. Selected to demonstrate the more important of the simple techniques and apparatus that the student will need to use.

A CONCISE GUIDE TO PLASTICS — Herbert R. Simonds — *Reinhold.* 318 p., illus., $6.95. An introduction to the ever-increasing variety of applications to modern plastics. Includes a list of manufacturers and what they produce.

CATALYSIS: Vol. V, Hydrogenation, Oxo-Synthesis, Hydro-desulfurization, Hydrogen Isotope Exchange and Related Catalytic Reactions — Paul H. Emmett, Ed. — 542 p., $15.00. This volume, the last of the series, deals with both the simple addition of hydrogen and the destructive hydrogenation or hydrogenolysis.

RADIATION SHIELDING—B. T. Price, C. C. Horton and K. T. Spinney — *Pergamon.* International Series of Monographs on Nuclear Energy, Division X, Vol. 2, 350 p., charts, $10.00. Work on the nuclear submarine, nuclear ships and nuclear airplanes have given more importance to the weight and cost of the shield for the reactor.

THE PHYSICS OF FLOW THROUGH POROUS MEDIA — Adrian E. Scheidegger — *Macmillan.* 236 p., illus., $14.00. Growing out of the need felt by research workers for a better idea of the present state of knowledge in the field.

THE FREEZING PRESERVATION OF FOODS: Volume I, Freezing of Fresh Foods—Donald K. Tressler and Clifford F. Evers — *Avi Publishing Co.,* 3d rev. and augmented ed., 1214 p., illus., $18.00. Of interest not only to those in the frozen food industry, but also to those who do freezing at home.

THE FREEZING PRESERVATION OF FOODS: Volume II, Freezing of Precooked and Prepared Foods — Donald K. Tressler and Clifford F. Evers — *Avi,* 3rd rev., and augmented ed., 559 p., illus., $10.00.

SIXTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION—Theodore Von Karman and others — *Reinhold* for the Combustion Institute, 943 p., illus., $28.00. These symposiums are intended to summarize and coordinate work in the combustion field.

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